SCHOOL SCIENCE AND MATHEMATICS

VOL. XXXIII, NO. 6 JUNE, 1933 WHOLE NO. 287

MATHEMATICAL FALLACIES

BY CECIL B. READ
The University of Wichita, Wichita, Kansas

An unfailing source of entertainment for the class or mathematical club is found in the multitude of mathematical problems in which an apparently correct chain of operations leads to an absurd result. These problems have considerable value in the teaching of mathematics. Not only do they provide a needed relief from what the pupil often feels is a tiresome task, but the associations are an aid to memory in recalling important facts which have temporarily been forgotten. No formal statement that division by zero is not permissible will impress the pupil to the same extent that he is shocked when he first sees a "proof" by algebra that 5 equals 7.

Such problems are commonly termed *Fallacies,* although the term *Paradox* has also been used. These terms are not interchangeable. The dictionary clears up the difficulty. A *paradox* is defined as (1) an assertion seemingly contradictory but that may be true in fact, or (2) a statement actually contradictory or false. Neither definition applies to the problems in question. We might use the term *sophistry:* a pretense of sound reasoning intended to deceive, but such problems are not used with intent to deceive. We admit the conclusion to be false; the problem is to find the flaw in the reasoning. Without any question *fallacy* is the proper term, the dictionary definition being "any unsound reasoning." In particular, we have the *Fallacy of False Cause,* sometimes called *Non Sequitur,* in which the conclusion is based on insufficient or erroneous reasons.

Many sources are available from which various fallacies may be obtained, for example, *Ball's Mathematical Recreations and Essays,* or *Licks' Recreations in Mathematics.* Frequently examples are discovered in current periodicals, as in the puzzle departments, or in the form of an appeal for help from some person evidently uninformed regarding the laws of mathematics. With the underlying source of error as a basis, endless problems can be created by the teacher as well as by the student to whom this work appeals. A few type examples will be given, from which an extensive list may be built up.

Absurd fallacies may cause considerable amusement, but puzzle no one but the beginner. To prove that a dog has nine tails:

	1 dog has 1 tail
	0 dog has 8 tails
Add,	1 dog has 9 tails.

Or, in like manner, a bottle ½ full equals a bottle ½ empty. Multiply by 2, and since $2 \times \frac{1}{2} = 1$, we have: a bottle full equals a bottle empty. Again, 20 cents = 1/5 dollar, and 50 cents = 1/2 dollar. Multiply term by term, and we have 1000 cents = 1/10 dollar.

The error may not be quite so apparent. The following was rather widely quoted a few years ago. It bothered one banker so much that he made a hasty trip to consult his neighbor, a college professor of mathematics. Assume we make a deposit of $50 in a bank.

withdraw	$20.00	leaving	$30.00
now withdraw	15.00	leaving	15.00
now withdraw	9.00	leaving	6.00
now withdraw	6.00	leaving	0.00
	$50.00		$51.00

We now present our figures to the bank, showing the discrepancy, and demand the extra dollar. Repeat ten thousand times, and retire for a while.

Division by zero leads to the majority of the fallacies first encountered in algebra. Two examples will be presented. To prove that any two numbers are equal. Let a and b represent the numbers, and assume that

$$
\begin{array}{lll}
 & a = b - x & \text{Multiply by } a - b \\
 & a^2 - ab = ab - ax - b^2 + bx & \\
\text{Transpose} & a^2 - ab + ax = ab - b^2 + bx & \\
\text{Factor} & (a - b + x)a \quad = (a - b + x)b &
\end{array}
$$

Divide by the common factor, and we have $a = b$. As the second example, let us solve the equation

$$
\begin{array}{ll}
 & 10x - 35 = 18x - 63 \\
\text{Factor} & 5(2x - 7) = 9(2x - 7)
\end{array}
$$

Divide by the common factor $(2x - 7)$ $\qquad 5 = 9$

Once the error is clearly understood, such examples will cause little difficulty, but the fallacy tends to appear in various forms. A recent book has this statement, "What is the value of $(x^2 - 1) / (x - 1)$ when x is equal to unity? Most pupils will reply 0 or 1, but the correct answer in this case is 2, as is seen by performing the division." The fallacy is doing its best to creep in; strictly speaking, the expression is meaningless for x equal to unity. We *assign* the limiting value, if it exists, as it does in this case.

A second class of algebraic fallacies depends upon the frequently neglected fact that a quantity has n nth roots, usually the difficulty is with the square root. Take the true equation $1 - 3 = 4 - 6$. Add 9/4 to each member

$$1 - 3 + 9/4 \ = 4 - 6 + 9/4.$$

Each member is now a perfect square

$$(1 - 3/2)^2 \ = \ (2 - 3/2)^2$$

Take the square root of each side, giving

$$1 - 1/2 \ = \ 2 - 1/2$$

or $1 = 2$. Another fallacy involving square roots is the proof that $1 = -1$

$$\sqrt{-1} = \sqrt{-1}$$

$$\sqrt{\frac{-1}{1}} = \sqrt{\frac{1}{-1}}$$

$$\frac{\sqrt{-1}}{\sqrt{1}} = \frac{\sqrt{1}}{\sqrt{-1}}$$

$$-1 = 1$$

The equation $\sqrt{x} - \sqrt{x+1} = 2$ yields an apparent solution after we raise both sides to the fourth power, with suitable transpositions. However, the solution fails to satisfy the equation. The student is incredulous, and only the bright student can explain.

A fallacy closely related to the above is the following 'proof' that a negative number has a (real) logarithm. Let p be any positive number, and let $P = \log p$. Then P is real, and $-p$ is negative. We also have $(-p)^2 = p^2$

Take logarithms $2 \log(-p) = 2 \log p$

$$\log(-p) = \log p = P \text{ which is real.}$$

Geometrical fallacies are perhaps more frequently seen, and of apparently more types than algebraic ones. A careful analysis will show that the majority of such problems can be divided into two types. The first type involves the use of a false theorem in the proof. For example, we can prove that any point on a line bisects the line by use of the theorem "Two triangles are congruent if two sides and an angle of the one are respectively equal to the corresponding parts of the other." The second type of geometrical fallacy involves the use of a false construction. For example, the theorem: There are two perpendiculars from a point to a line. Proof: Let two circles, M and N, intersect in B and F. Draw the diameters AB and BC. Let AC cut circle N in D and circle M in E. (A is on circle M.) Then draw BD and BE. Then angles AEB and BDC are each right angles, being inscribed in a semicircle. The flaw in the proof is obvious if the construction is attempted, but if a figure has been previously prepared, with E on minor arc FB of circle M, and D likewise on minor arc BF of circle N, with both points close to F, the average geometry class will be greatly puzzled. Many geometry texts contain such fallacies as a challenge to the student.

Divide a line AD into three equal parts by the points B and C. We then have the ratio $AB/BC = BC/CD$. Cancel like letters in each ratio, and we obtain $A/C = B/D$. That is, we now have four *points* such that the ratio of the first *point* to the second is the same as that of the third to the fourth.

Fallacies may appear due to errors in manipulative processes, particularly when the attention is primarily directed toward the principal operation or the final result. The following example, presented yearly to college sophomores studying

maxima and minima, has never failed to puzzle the class. It is proposed to prove that every ellipse is a circle, by using the differential calculus to show that the radius vector of the curve, written in polar coordinates, has no maximum or minimum. In rectangular coordinates, the ellipse has the equation

$$x^2/a^2 + y^2/b^2 = 1.$$

To transform to polar coordinates, we substitute $x = \rho \cos \theta$ and $y = \rho \sin \theta$, and clear of fractions, obtaining $\rho^2 b^2 \cos^2 \theta + \rho^2 a^2 \sin^2 \theta = a^2b^2$. Factoring ρ^2 from the left hand side, we have, since $\sin^2 \theta + \cos^2 \theta = 1$, $\rho^2 = a^2b^2$ or $\rho = \pm ab$. To find when ρ is maximum or minimum, we compute $d\rho/d\theta$ and equate to zero. But this derivative is zero at all times, hence ρ has no maximum or minimum values. That is, since x the radius vector is not increasing or decreasing continually, it is always the same, hence every ellipse is a circle.

For further experimentation, the teacher may be interested in attempting to prove that $2 = 1$ by taking the infinite series for log 2. By properly rearranging and grouping, we can make the series converge to the limit zero. Hence $\log 2 = 0$, but as $\log 1 = 0$, we have $2 = 1$.

In conclusion, attention should be called to the fact that technically, any mistake is usually productive of a fallacy, but the absurdity of the result is seldom apparent. What the teacher clearly perceives is a fallacy may by no means be apparent to the pupil. For example, the pupil states that since $\tan 4x = 4$, $\tan x = 1$, hence $x = 45°$. In like manner, a beginning student offers the following: $\cos 28° = \cos x$, therefore $x = 28°$, because we have divided out the factors c, o, s, from each side of the equation. It is apparent that if a fallacy is to be used as a recreational teaching device, the fallacy must be one that is obvious to all students.

Sleep, riches, and health, to be truly enjoyed, must be interrupted.—RICHTER.

No true and permanent fame can be founded except it labors which promote the happiness of mankind.—CHARLES SUMNER.

Culture is to know the best that has been said and thought in the world. MATTHEW ARNOLD.

TESTS IN BIOLOGY

By R. W. Tyler
Ohio State University, Columbus, Ohio

Usually discussions of this topic are arguments for or against new type-tests as opposed to essay examinations. Apparently the question of the form of the examination has engrossed the attention of teachers to the exclusion of other questions. It is my belief that this concentration upon the form of the test has hindered the development of more satisfactory tests in biology. The situation is very similar to an argument over the merits of particular automobiles in which all of the discussion centers around the advantages of a coupé in contrast to a roadster. The type of body is, of course, a factor in selecting an automobile, but the first question ought to be concerned with the effectiveness of the motor. An automobile is purchased for certain uses and the value of the machine must be judged in terms of those uses. In the same way a test or examination is made for certain uses and the problem of first concern to teachers should be the value of particular examinations for the uses to which they are to be put.

What are the uses which an examination must serve? Tests are given in order to discover the difficulties which the class is having so that the teaching emphasis may be directed toward overcoming these difficulties. Tests are also given in order to discover the difficulties of individual pupils so that they may direct their study more wisely. Tests also serve to give the teacher an estimate of the effectiveness of his own instruction. If his class shows consistently higher achievement on examinations this year than was true last year the teacher concludes that his work has been more effective this year than last. The administrators of the school are also often interested in getting through the use of tests an estimate of the effectiveness of instruction. Increasingly tests are also being used to determine the effectiveness of particular teaching procedures, or particular methods of selecting and organizing course materials. All of these uses require tests which really show how well the pupils are progressing in their school work. Hence a satisfactory test or examination must first be one which actually gives us evidence of the amount of progress which pupils are making.

What constitutes progress in school work? It is certainly true that every change which takes place in a pupil during the time he is in school cannot be considered progress. During the time he is in high school the pupil may grow taller, he may grow fatter, he may acquire a new slang vocabulary, his voice may change, but we do not consider these as evidences of the progress of pupils in their school work. Each subject which is taught in the school is offered with the expectation that pupils who take this subject will undergo certain desired changes as a result of the course. In arithmetic, for example, it is expected that pupils will acquire a certain understanding of the meaning of number, and that they will become somewhat skillful in solving numerical problems. These changes which we expect to take place in the pupil are the objectives of the subject. It is apparent that a satisfactory test in arithmetic is one which shows us the degree to which pupils are reaching these objectives, that is, the degree to which they have acquired an understanding of the meaning of number, and the degree to which they have become skillful in solving numerical problems. In similar fashion every subject offered in the school involves certain objectives which we hope pupils will reach as a result of instruction in this subject. A satisfactory test or examination in any subject is an instrument which gives us evidence of the degree to which pupils are reaching the objectives of the subject.

Considered from this point of view it becomes necessary to enlarge the common conception of a test or examination. Many people have limited the concept of an examination to a paper and pencil test. This is obviously a harmful limitation. Sometimes the best way to get evidence of the desirable changes which are taking place in pupils is through observation, or by other means. To use only paper and pencil tests might seriously restrict the opportunity for determining the progress pupils are making.

Another fact emerges when we consider tests from the point of view of their uses. The value of a test must be judged by whether it is an effective tool for determining how well the pupils are attaining the important objectives of instruction. This means that teachers must formulate the objectives which they are trying to reach in a particular course and then make or select tests which cover each of these objectives. Failure to do

this in the past has made our uses of tests ineffectual and ofttimes pernicious. This is illustrated in biology just as well as in other fields.

Consider the objectives of biology instruction. Of course these vary somewhat with different instructors and the relative emphasis placed upon some of the objectives may be vastly different in different schools. Nevertheless, I know of no biology teacher who does not believe it important for pupils to reach several objectives. Most teachers want their pupils to acquire a fund of important biological facts. Most of them expect the pupils to become familiar with the meaning of the more common technical terms in biology. Many expect the pupils to learn to apply biological principles to new situations which may arise. Many also expect the pupils to learn at least the rudiments of scientific method and to be able to apply this method to simple biological problems. It is usual for teachers to expect their pupils to develop some skill in the use of the microscope and other essential biological tools. Undoubtedly these represent but a portion of the objectives which biology teachers generally are striving to reach. Nevertheless when we compare the tests and examinations in common use with these objectives it is evident at once that these tests do not show us how well the pupils are attaining all of these objectives. Typical tests and examinations give us evidence only of the progress pupils are making in acquiring biological facts and of their understanding of the meaning of technical terms in biology. Rarely do we find the pupils tested on their ability to apply biological principles to new situations, on their ability to utilize scientific method, and on their laboratory skill. How then can we be content to determine the difficulties pupils are having, to judge the effectiveness of our instruction, and to evaluate the merits of teaching procedures by means of tools which give us only a fraction of the true picture? Surely the improvement of this situation is the most important problem in testing.

The answer which is sometimes made to this criticism is that the acquisition of information is basic to all other objectives. It is claimed that one cannot think without facts, hence the test which reveals the degree to which pupils have acquired important facts, indirectly constitutes a test of all of the objectives of instruction. This claim, however, is not justified. In our botany and zoology classes at the Ohio State University we have been comparing the records of the pupils' grades on

tests which show the degree to which they have acquired important facts and tests which indicate how well they are able to apply principles to new situations. The results are by no means identical. We have found many students who have acquired a large number of important biological facts who are unable to apply these facts to new situations. We do not have a complete picture of the progress pupils are making when we depend only upon tests of the acquisition of information.

If we are to improve the tests in biology it must be done by formulating all of the important objectives which we are trying to reach in our biology teaching and then to develop tests or examinations which will give us evidence of the degree to which pupils are attaining each of these important objectives. Our botany and zoology departments at the Ohio State University have been engaged on this task for several years, and have shown that it is possible to improve examinations in this way. After the objectives have been formulated the task of developing tests for a particular objective is largely that of developing a set of exercises which gives the pupil a chance to demonstrate that he has reached this objective. We recognize this in certain fields but we have neglected it in biology. Thus, for example, if we want to discover how well the pupil has learned to add fractions, we present him with a series of exercises which give him a chance to show his skill in adding fractions. If at home, we wish to see how well our boy has developed the habit of tidying up his room each morning, we observe him daily in the situation in which he has a chance to tidy up his room to discover the degree to which the habit has been developed. In general we may say that an appropriate test for any objective consists in presenting the pupil with situations in which he has a chance to show the degree to which this objective has been reached and in which we have a chance to get a record of the pupil's reactions in these situations.

In improving biology tests we may employ the same essential procedures. For example, to develop tests of the pupil's ability to apply biological principles to situations new to him we must collect a number of situations new to the pupil which give him a chance to apply these biological principles. By presenting these situations to the pupil and getting a record of his reactions we obtain a test of his ability to apply biological principles. As an illustration of such a test situation the following has been used in an elementary course in zoology.

Two live frogs each weighing 60 grams are selected and two small crayfish each weighing twenty grams are also selected. One crayfish is fed to each frog. The frogs are kept at 60°F. for three hours and then one (a) is put in the ice chest at 40°F. and the other (B) is kept at 80°F. in a warm room. What differences will be found in the state of digestion of the crayfish at the end of 48 hours, and why?

Since this situation is new to the pupils and permits them to apply biological principles in explaining it we can use it as a test exercise. In the same way if we wish to test the pupil's ability to interpret biological experiments which are new to him we can present the descriptions of such experiments to the pupil and ask him to formulate the most reasonable and complete generalization which he can infer from the results of the experiment. The following exercise illustrates such a test situation which is used in our zoology class.

Protozoa are found in the intestine of certain termites (white ants). These protozoa can be removed from the intestine without causing any physical injury to the termite. The protozoa feed on wood pulp which is eaten by the termites. Thirty-six of these termites were selected for an experiment. The protozoa were removed from the intestines of eighteen of them. These termites ate wood pulp but continued to lose weight, became inactive and soon died. The other eighteen termites were observed during the same period. They lost no weight, and were active throughout the period of observation. State the most reasonable and most complete interpretation which you would make of this experiment.

As a third illustration of the possibility of testing a wider variety of objectives than are usually covered in examinations let us consider an objective which does not involve a paper-and-pencil test. One of the objectives commonly stated for biology is to develop a certain minimal skill in the use of the microscope. This may be tested by presenting the pupil with situations which require the use of the microscope and then by means of a simple check list[1] the teacher may record the pupil's difficulties as well as an estimate of his general skill in using a microscope in these situations.

These illustrations should make clear that one evidence of the value of an examination is to be found in noting whether the examination actually presents situations which give the pupils an opportunity to show the degree to which they have reached all of the important objectives of that subject. It is possible for any teacher who has formulated clearly his objec-

---

[1] This check list is described in Tyler, Ralph W. "A Test of Skill in Using a Microscope," Educational Research Bulletin, Vol. 9, pp. 493-496.

tives to examine biology tests and to determine whether the tests are complete enough to cover every one of these important objectives. If they do not the examinations should not be used or else they should be supplemented by other tests which cover the objectives which are left out.

There are, of course, other important problems in testing which I shall not have time to consider in this paper. The question of the length of satisfactory tests, the methods by which wide variations in grading may be eliminated, and procedures for improving the emotional reactions of pupils to tests are all worthy of treatment. At this time, however, I shall limit my discussion to the one major issue. The ease of administration and scoring is not the first factor to consider in choosing or making a test. It is quite easy to measure the height and the weight of a pupil and do it rather objectively. However, to increase the height and weight of a pupil is not a major goal to be reached in biology classes. Hence, to consider bath scales and yardsticks as satisfactory test devices for biology classes because they are easily administered and objectively scored would be silly. That is to say, the ease and objectivity of scoring is significant only after we are sure that the test gives us the kind of measurement which is essential. The primary question which we should be able to answer in the affirmative for the tests we make or use is: Do these tests give us evidence of the degree to which the pupils are attaining all of the important objectives of biology?

YOUTH FORCED TO PAY THE BILL

From an Address by DR. LOTUS D. COFFMAN

If the political and economic leaders had followed the teachings of the schools, we should not be in our present difficulties. The schools never taught war, they taught peace; the schools never taught extravagance, they taught thrift; the schools never taught disregard for law, they taught respect for law; the schools never taught national isolation and selfishness, they taught international participation and coöperation. Now the people, as they strike out blindly to save themselves from economic disaster, are about to wreck the schools as if that would accomplish their end. We can find millions for highways, billions for public enterprises, but we must pare and scrimp on education. We are making helpless children and youth in need of higher training for professional leadership, pay for our folly.

LABORATORY WORK IN GEOGRAPHY

By William J. Berry
Western State Teachers College, Kalamazoo, Michigan

FIELD GEOGRAPHY EDUCATIONALLY SOUND

Johann Amos Comenius, about 1650 wrote "Men must be instructed in Wisdom, so far as possible, not from books, but from the heavens, the earth, the oaks and beeches; that is, they must learn and investigate the things for themselves, and not merely the observations and testimonies of other persons concerning the things."

It is, of course, recognized by all that knowledge comes through concrete experiences. Instruction by means of books becomes effective only as students transfer their own experiences into the settings they read about, and thus, in effect, get further experiences upon which to build.

True laboratory work in any science consists of discovering and recording, in so far as the student is concerned, results of the interaction of various factors or forces with which the particular science deals. According to the above interpretation, therefore, laboratory work in Geography may be called field work, though not all work now labelled geography field work, can be properly called laboratory activity.

LABORATORY WORK VS. WORK-ROOM ACTIVITIES

Let us at the outset distinguish between real laboratory work in Geography and work-room activity. The manipulation of statistical materials, such as graphing climatic data, production information, and other similar data are not properly laboratory work for they do not give exercise in *observing* geographic phenomena, namely man's utilization of natural environmental features and conditions. The work-room activities may be ever so valuable as geographic exercises and are certainly to be commended but they must of necessity be devoted to synthesis of knowledge resulting from the observation of others rather than to direct *observation* of human business in its normal natural setting. Some exercises with good pictures and with topographic or soil maps may be quite as valuable as actual field work in the area mapped, but the student in geography can do real laboratory work only where there is an opportunity of observing, first-hand, human activities of some sort and the natural setting in which they are being carried on.

SOME COMPARISON OF THE DEVELOPMENT OF LABORATORY WORK IN VARIOUS SCIENCES

Laboratory work was done first in physics, but for a very long time the laboratory was used only as an instrument for research. Not until the middle of the nineteenth century was laboratory work made a part of educational procedure in that science. Chemistry was really the first to take up the direct mode of study as a class activity. No doubt chemistry took the lead because the difficulties encountered in providing for direct observation experiences were less potent than with other sciences. Physics soon followed the example of using such observation as a part of the teaching procedure. The difficulties encountered were greater than in the case of chemistry but not insurmountable. Geology and the biological sciences have been taught by the classroom laboratory method to a considerable degree, but these last named sciences early saw the need, not only of bringing a few of their materials for study into the classroom, but also of taking the class out to observe natural phenomena. This sort of study is commonly called field work, rather than laboratory work. However, the objectives are those of the indoor laboratory and the methods are not fundamentally different. The chief difference is merely that of taking one to the things he is to observe instead of bringing those things to him. The procedures function alike in educational objective. With geography it is quite out of the question (for direct study) to bring actual landscape into the school, and in actual landscapes can direct observation of human adjustments to natural environment be made. Therefore, most laboratory work in geography must be done away from the class-room.

GEOGRAPHERS HAVE THE RICHEST LABORATORY OF ALL

While materials for Geographic observation cannot be brought indoors, of all types of laboratories surely the most splendid is that in which geographers may study. Since geography is the science of man's relationships to his natural environment, wherever man lives, works or plays there are possibilities for geographic study. Surely no other study offers a field so great in variety, interest and possibilities. On the other hand, none has its equal in complexity. Further, none is so readily available nor so universally distributed. But may we always keep in mind that it is not feasible for all phases of geography to be studied by direct methods for such would lead

the student into all parts of the world since Geography must be world-wide in its scope. Yet many geographic facts may be gained through local field-laboratory work, and, more than that, it is chiefly through the use of the geographer's field laboratory that skill may be attained in original geographic study. Geographers are agreed that our subject is not one that synthesizes the findings of other workers but rather that geographic study must at the outset be based upon field activity. With this in mind, we may say that students of geography should never be allowed to leave us until they have gained skill in field study of laboratory rather than of research grade.

TECHNIQUES DEPEND UPON OBJECTIVES AND ON AREA AVAILABLE

As to the techniques employed in geographic field study, a great deal depends upon the objectives in mind and a great deal more on the areas available for study. It seems, after consideration of field work as it has been done in a number of schools in different parts of the country, that one may well group the different procedures employed into a few major types based upon not only the characteristics of the studies made but also upon levels of difficulty and therefore on levels of student advancement. It would seem that the different levels would have many examples for study in any locality where there might be a desire for field work of laboratory, rather than of research grade. Always it must be borne in mind that any study that does not consider both a human activity, or business, and at least one element of natural environment to which that human item is related either directly or indirectly cannot be a geographic exercise. Really, the study to be geographic should consider all the natural items of consequence to which the human item is related.

FIELD-WORK OF FIRST LEVEL

In the opinion of the writer, in the first level of field geographic study should be taken up such studies as involve consideration of single businesses in their relationships to, or utilization of, the complex of natural environmental features and conditions. To illustrate, we cite a few specific cases. In many parts of Michigan there are agricultural activities in which each unit is quite restricted in areal spread and which are exploited at these particular places largely because of certain

slope or soil conditions themselves of patchy distribution. In the Kalamazoo neighborhood the celery patches are excellent examples. One of these celery units would be a splendid object of study. The instructor would choose a certain one for class study and would give directions for the study of that particular business unit. The class would then proceed to find out, according to the method of procedure outlined for it, the reasons for the establishment of that business in that particular setting and to discover in what fashion the various natural items had been significant in the development of celery-growing there. The study would involve a consideration of the various associated crops with their seasonal or rotational significance, such as celery, cabbage, and pansies. Other areas might have a different crop to emphasize—the chicory district for example would consider chicory instead of celery; and there would be the areas of mint, cucumbers, grapes, cherries and others of specialized cropping. In each of these the emphasis would be different from the others but the methods of study would involve the same general sorts of procedure.

In this same level of study would come such projects as an individual industrial plant: a creamery, a pulp-mill, a flour and grist mill or a cement plant. Each of these items is a single business unit of not very great complexity. It, no doubt, would be related to a few natural conditions at that place in a definite and obvious way. The saw mill would be related to stands of timber not far distant, water highways, a waterfall with power possibilities and other items. The grist mill would be related to nearness of farming lands, water-power, routes for travel to markets and supplies of one sort or another. No doubt the class would need to consider the impetus of an early start in many cases. Not all of these studies would be of equal difficulty, though in general the types of student activity would be roughly similar in all of them. Primary industries in general are less complex than manufacturing and trade based on them. A case of such study of difficult nature, and probably not a good one for students doing work at the beginning of this level might be the paper mill at Parchment, Michigan, or one of the automobile factories of the Detroit area. In every locality studies of this somewhat more difficult kind are legion. They might involve a pottery establishment at Zanesville, a coke oven along the Monongahela, a paper mill here or a cement plant there. Every locality has a variety of such studies await-

ing use by a geography class. The procedure in class study would be merely the consideration of interrelations between that particular business (including the cultural stage of human development or the cultural heritage which it represents) and natural environmental features and conditions or items. The class would not, probably, find all the facts that explain the business development, but they would presumably, find out the significance geographic relationships.

SECOND-LEVEL FIELD WORK

A second level of direct-method study would involve *area studies*. It would seem that one area might be just about as good for this as another. If the area had but little variety, for instance a farming area near Grand Forks, North Dakota or Streator, Illinois, the area studied might be comparatively large while a study involving an area of considerable variety would be less widespread.

The study would presume to notice and record all the important human activities of the area and to investigate all the more important relationships to natural items, particularly those near at hand.

At least two phases of such areal study would appear. Surely there would be great differences between rural and urban studies. Considering first an urban area, the study would involve the various urban developments of the city, or section of the city, studied. The class would be concerned with the localization of various phases of urban development—the retail district, the manufacturing district, the wholesale district, the residential districts and within this a probable subdivision into grades one, two and three, with outlying retail developments and other types of localization. The section might be mapped and the class investigate with a view to explaining the localization of the various types of development.

In like fashion a rural section might be studied with a view to seeing and explaining the agricultural pattern, the farmstead layout and the various cultural items of the rural landscape. No doubt it would be well at the outset to map the area studied, but in no sense may the map be considered the final product of study, but rather it becomes a convenient tool for the rest of the study. From this map may be made other maps and ever so many graphs, depending on the various phases desirable for exhibition in the study.

A convenient scheme for the map is that it be made on cross-section paper with scale eight spaces to the inch. Thus on the scale of a mile to the inch each square stands for ten acres, or for two and one-half acres when the scale is two inches to the mile. The class will do well to devise its own scheme for indicating the facts mapped, though it is doubtful if any scheme of indicating the things mapped is better than the so-called "fractional complex" scheme that is now in rather general use. That scheme is especially useful because of the great variety of other maps that may be based upon it.

THE SUB-REGION, OR THIRD LEVEL STUDIES

A more advanced level of field work involves sub-regional studies. The sub-region that is here held in mind is the geographic unit of lowest order. The studies that have been indicated above are in no sense units but rather items or parts of units. A type study of the third level might well be the community. This sort of study is farther along in complexity and calls for knowledge based upon the studies described above. It involves selection of area with completeness of the unit in mind; it involves delimitation of the community and the probable inclusion of both rural and urban studies.

To mention a few examples. The writer has in mind the Corona, California, locality. Corona, a city of some seven thousand people, is the center of a rural district with some ten thousand inhabitants including the people of Corona. The community is almost wholly rural in its interests. Aside from a small clay works there is no basic activity not based upon agriculture, the utilization of agricultural materials in industry or the sale of goods to agriculturists or people of the industries indicated. The boundary between the Corona community and other nearby population groups lies in a wide belt of unused land. The concentration of people in and about Corona together with the district in which they live constitutes a definite geographic unit and would be an admirable study for students of this level. Another phase of this work would involve the geographic unit not separated from other units by a definite transition or contrasting strip of land. I have in mind one in central Iowa with the community center in the village of Lohrville. It is an example of one of thousands similar in that part of the country. The Lohrville community is not set apart from surrounding communities by any sort of contrasting developments or stretches of unused

land. The town is the business, social, educational and political center for the people of some two townships. Because of this community of interest with definite focus and because of the many other entities of similar status, the Lohrville community may well be considered a small geographic unit which is in turn a part of a very large geographic region. The two regional units, Corona and Lohrville present different degrees of difficulty and several contrasting problems, particularly the problem of delimitation. Yet the studies are essentially the same.[1]

THE GEOGRAPHIC REGION

The next higher level is the Geographic Region. Its size and complexity ordinarily places it beyond the scope of class study and into the realm of research. Thus it may not be considered as a possibility for our laboratory.

FIELD WORK NOT LIMITED TO RESEARCH

Field work as carried on by the ordinary class definitely is not research but is truly laboratory work. The student observes geographic phenomena, that is, the inter-relationships between man and his natural environment, and he makes his observations according to instructions. He makes these observations however for the sake of discovering in so far as he is concerned, some facts of geographic significance. It bears the same relation to geography that mixing chemicals to note results bears to learning process in chemistry. It does, however, provide a training which is indispensable for later research work.

FIELD WORK MAY NOT BE CONSIDERED AS ALL-SUFFICIENT

We may not infer that all phases of geography may be studied by our classes in the field. Geography must be worldwide in its scope and so only a very limited areal part may be taken up by our classes by direct observation. However, field work does help materially in (1) Effective study of the local

[1] A goodly number of studies have been made at this level by trained geographers, both individually and as class projects, the results of which studies have been published in recent geographic literature. Most of the studies are from areas presenting problems that only advanced classes may hope to handle. Here is listed a few of these studies: (1) "Detailed Field Mapping in the Study of Economic Geography of an Agricultural Area," W. D. Jones and V. C. Finch. *Annals of the Academy of American Geographers,* Vol. XV. (2) "Field Maps for the Geography of an Agricultural Area," D. S. Whittlesey. Ibid., Vol. XV. (3) "A Detail of Regional Geography," R. S. Platt. Ibid., Vol. XVIII. (4) "The Blackstone Valley," Preston James. Ibid., Vol. XIX. (5) "An Urban Field Study," R. S. Platt. Ibid., Vol. XXI. (6) "Jordon Country," Isaiah Bowman. *Geographical Review,* Vol. XXI.

area, (2) Comparative study of other areas, (3) Teaching methods of independent study (investigative technique in interpreting landscape phenomena geographically).

Further, field work in most cases should not be the first kind of geographic study, either for grade, high school or college classes. It is not in conformity with sound educational procedure to take up first of all a kind of activity relatively difficult to analyze geographically and surely few parts of the world present more complex relationships than the part of the world in which we live.

Yet much good must come from field work, and present trends indicate increasing importance in field work as has been the trend of laboratory work in development of other sciences.

ATTENTION, MATHEMATICS TEACHERS!

All mathematics teachers are invited to attend a round-table conference in Mathematics on July 3, 1933 at 3:00 P.M. at the Stevens Hotel, Chicago, Illinois.

At this meeting Mr. E. C. Hinkle of the Chicago Normal School will preside. The topic for discussion is "Mathematics in the Changing Curriculum of the High School," and it will be presented by Mr. Edwin S. Lide, specialist in the National Survey of Secondary Education. Leaders of Discussion will be: Wm. Betz, Department of Mathematics, Alexander Hamilton High School, Rochester, N.Y. and President of the National Council of Teachers of Mathematics, and Dr. E. R. Breslich, University of Chicago.

Following the Round Table Conference in Mathematics on July 3 there will be a joint dinner meeting of the *Mathematics Section of the Central Association of Science and Mathematics Teachers* and the *National Council of Mathematics Teachers* at which Dr. C. A. Stone, the president of the Central Association of Science and Mathematics Teachers will preside. Professor W. W. Hart of the University of Wisconsin will discuss "Mathematics from the Standpoint of the Educator," Dr. H. E. Slaught of the University of Chicago will speak on the topic "Retrospect and Prospect for Secondary Mathematics," and a third speaker to be chosen will speak on "Applied Mathematics—Necessary in the Social and Physical Sciences."

The price of the dinner will be $1 and the place the Great Northern Hotel. These meetings may well turn out to be epoch making and all those teachers interested in the welfare of mathematics should attend these meetings if it is at all possible.

AN ELEMENTARY STUDY OF DIFFRACTION PATTERNS

By John B. Dutcher
Indiana University, Bloomington, Indiana

In the laboratories of the Department of Physics at Indiana University are two or three large tubes loosely termed diffraction cameras. These so-called cameras have been used both in research and in the ordinary routine work of the optics laboratory courses. Several generations of students have found interest in working with these rather simple devices, and many diffraction patterns have been studied, some by direct visual observation but most of them by means of photographs.

Many requests come to the laboratory asking for some details of the construction of this piece of apparatus. These requests have prompted the writer to give this brief description of the equipment and its use.

Students of optics are acquainted with the principles of diffraction which may be found in such books as Robertson's "Introduction to Physical Optics," Edser's "Light for Students," Wood's "Physical Optics" and to some extent in texts on general physics. A discussion of the subject has no place in an article of this nature.

A student who has studied light by means of the principles of geometrical optics is loath to believe that light may "bend around" an object. To a beginner the following well known example is always most surprising.

If light from a *small* source be allowed to fall on a small steel ball (½ inch diameter) placed, say, 12 ft. from the source, the space beyond the ball is shielded from the light. This space is known as the shadow. If a screen of white cardboard be held some distance beyond the ball with its surface perpendicular to the line passing through the source and the center of the ball a dark spot (a cross-section of the shadow) will be seen. This is practically the geometrical projection of the ball on the screen. Now geometrical optics gives no hint that any light from the source gets into this shadow. As a matter of fact, if we examine the screen closely under proper conditions we will find a bright spot of light at the very center of the shadow. This spot of light may be seen with the screen at various distances beyond the ball and in books on optics is known as the Arago

spot, after the discoverer. It is not merely a spot but is an inverted image of the small source not unlike the real image formed by a converging lens. For example, if the source be a small brightly illuminated opening shaped like the letter V the spot image will be an inverted Λ. It is not within the province of this paper to try to show the origin of the light producing this spot. The following suggestion, however, might lead the experimenter into further study. Make the source a small round brightly illuminated pin-hole (about 1 mm. diameter), place the eye at the exact center of the shadow (use translucent screen), remove the screen and look at the ball, which of course must be directly between the eye and the source so the Arago spot falls on the pupil. With a little care one will be able to see a bright ring of light surrounding the ball like a shining thin filament. The above phenomena illustrate merely the beginning of the study of the distribution of light in the geometrical shadow of a ball.

Outside the geometrical shadow (near the edge) may be found an interesting distribution of the intensity of the light. This takes the form of fringes (circular rings in case of the ball) that vary in width and distinctness becoming narrower and fainter as the distance from the edge of the shadow increases. These fringes appear along the straight-edge shadow of a safety razor blade substituted for the ball. In fact, with a little care, the interesting distribution of light both within and without the geometrical shadow of many small obstructions may be observed.

Students in our classes have successfully observed and photographed the diffraction patterns due to such small obstructions as glaziers' points, needles, small screws, etc. However, we are not limited to small obstructions for our patterns. Small apertures or groups of small apertures give most surprising and beautiful results. To accomplish this a screen is placed at the position occupied by the ball. This screen obstructs all the light except that which passes through a small aperture cut in its center. The aperture may be round or rectangular, or any other shape desired. The necessary conditions are that it be *small* and the edges *clean* and *smooth*. Any small defect on the edges, such as dust particles or fine nicks, will cause most objectionable flares and brushes in the pattern. This precaution applies to the outer edges of obstructions also. For example, a small speck on the

edge of the disk of the ball as seen from the position of the Arago spot will cause a disturbance to run in toward the center of the shadow.

The simplicity of the equipment required is surprising to most people who make inquiries. In general the "camera" is arranged as shown in Fig. 1. T_1, T_2 are tubes each, say, 12 ft. long and

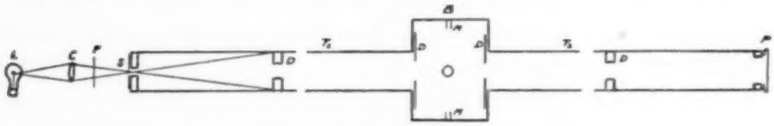


FIG. 1. Diagram of the diffraction camera.

from 4 in. to 10 in. in diameter. B is a small light-tight box having a lid on top or a door on the side which permits the adjustment of the shadow casting object. S is a wooden disk fitted into the end of the tube. This disk has a 1 inch hole in the center over which may be placed, in any convenient manner, a small thin sheet metal (tin) shutter having a small hole to serve as a *source*. P is a wooden ring fitting into the tube and supporting a simple camera back having a ground glass or other translucent screen and taking a plate holder which will carry either 4 × 5 inch or 3¼ × 4¼ inch photographic plates. Ring diaphragms

FIG. 2. An illustration of the Arago spot in the shadow of a ball.

D, D, D, made of wood or wallboard and wrapped with dull black cloth may be put in such positions in the tubes and box as will best prevent direct reflection from the sides of the tubes upon the ground glass or photographic plate.

The light scource L is a condensed filament incandescent lamp, the image of which is focussed on the pin-hole at S by means of a lens C. The lamp filament, the principal axis of the lens and the pin-hole, must, lie on the central axis of T_1T_2 for good results. At MM are slots into which may be slipped a

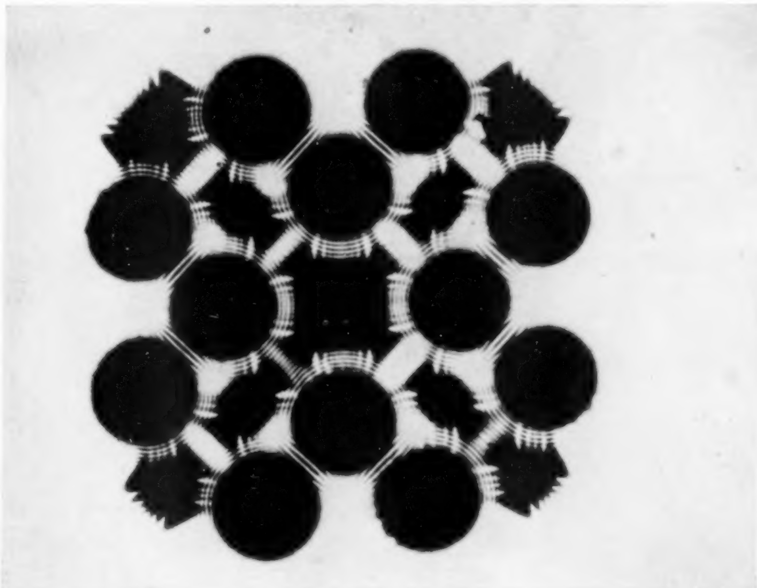


FIG. 3. The pattern produced by the use of a group of apertures formed by placing the heads of four desk keys together. Each key head had three round holes. Many of the details seen on the original plate are lost even in the first transfer. Each round hole shows a series of circular fringes on the plate.

wooden or wall board diaphragm having a round hole in the middle (diameter 3 inches, say) in which may be suspended the ball, etc. The ball may be held in place by sticking it to a sheet of good grade glass (photographic plate) with one drop of cement, or it may be suspended by a single wire (about #20 copper) soldered to the side next the source S. The wire should hang vertical, with both ends secured to the diaphragm, the ball being attached at the middle.

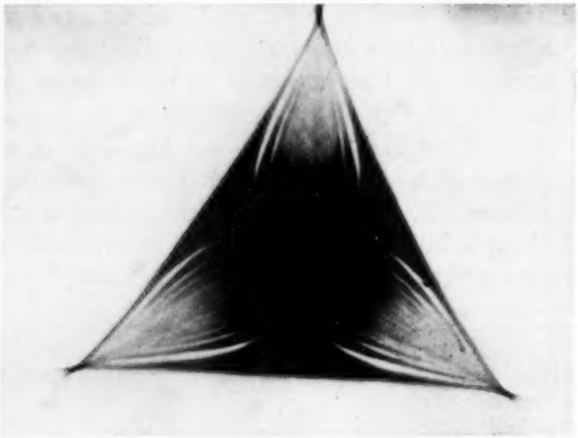


FIG. 4. A negative of a pattern obtained by means of the triangular aperture formed by using three pennies. This is closely related to the more complex one which follows:

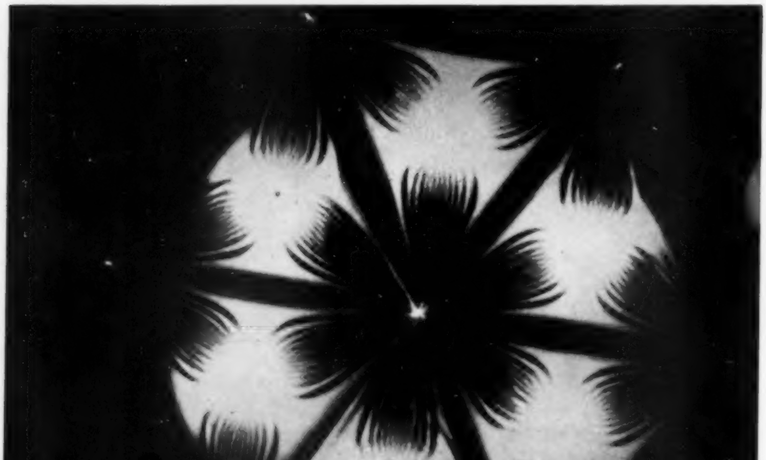


FIG. 5. A pattern obtained by the use of seven pennies. Six of these pennies formed a closed ring around the seventh, each of the six touching the central one. The bright spot in the center of the figure is in the very center of the shadow of the seventh penny. The brush-like figures radiate out from this bright spot. The reader may use his imagination regarding the location of the centers of the shadows of the other six pennies.

A second wallboard diaphragm may be constructed with a much smaller hole in the middle, over which may be placed smaller sheets of material having the necessary small apertures. Rectangular or triangular apertures are easily obtained by the use of four or three safety razor blades. The dimensions should be between 1 mm. and 3 mm. For photographs the time of exposure must be determined by trial. With a hundred watt condensed filament lamp and a pinhole source 1 mm. in diameter, it requires about 15 seconds for the Arago spot. To get details in some of the others, filtered light (approximately blue)

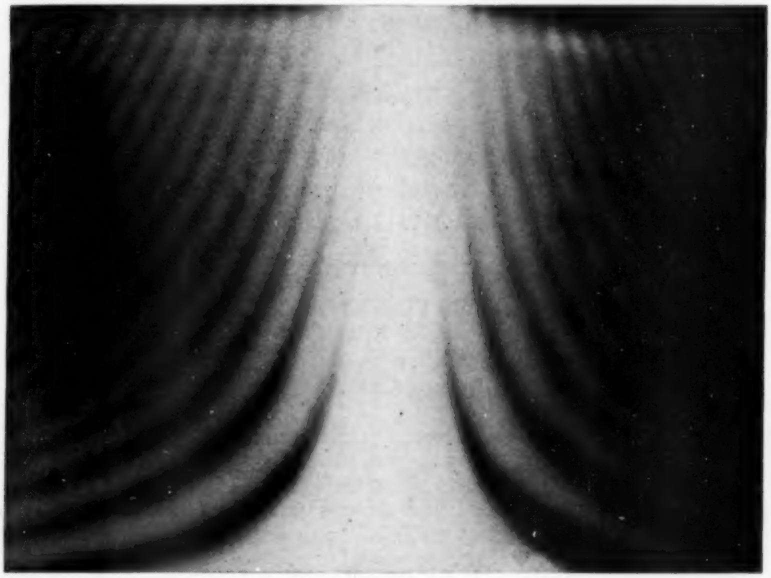


FIG. 6. A V-shaped slit between the edges of two safety razor blades. The slit was about four centimeters long, one millimeter wide at the top and diminished to zero width at the bottom. The original plate shows nearly thirty fringes. It was made with a nearly monochromatic source and required an exposure of more than one hour.

must be used, in which case exposures may require from 10 minutes to one hour. A piece of ordinary blue glass does fairly well as a filter when placed at F. Better filters can be purchased at a small price. Except for the camera back, the cost of the entire outfit is exceedingly small.

One of our outfits was made of two large heavy paper tubes (each 12 ft. long, 5 in. diameter) on which linoleum is rolled for shipment. They were obtained from a local house furnish-

ing company for the asking, and were blackened inside with a thin dead black paint by means of a rag swab on a long handle. The compartment B was made of a small wooden box blackened inside, and even the camera back is home-made. In fact, everything can be constructed easily by the ordinary student except, of course, the lamp, the lens and the plateholder.

The success of visual observation depends, of course, on having a good ground glass and a darkened room. Greased paper or tracing cloth, or even a sheet of glass *very* lightly covered with "Bon Ami" may be substituted for the ground glass. If the tubes and box are strictly light tight the photographs may be taken in any lighted room.

Some of the patterns obtained by students in their ordinary routine laboratory work are reproduced here. The patterns lose considerable in reproduction, but there are enough details to show some of their symmetry and beauty. Among the students responsible for these patterns are Mr. Lowell C. Warner, Mr. Herbert C. Hazel and Mr. O. O. Hall.

PUPIL ACTIVITIES FOR VITALIZING SCIENCE

By Louis T. Masson, *Riverside High School, Buffalo, N.Y.*

1. Making an electric cell out of an apple, lemon or berry, using two strips of different metals.
2. Making a home-made galvanometer for this cell, out of a medium-sized pill-box, some wire and a magnetic compass.
3. Construction of models to represent the electric structure of atoms of various elements, made of heavy copper wire, with corks of different sizes for nucleus and electrons. All joints to be soldered and the models painted in harmonizing colors.
4. Davy safety lamp made from wire gauze and a candle.
5. Making of a stroboscope to illustrate the reason for the appearance of wheels in motion pictures that appear to be standing still or moving backward.
6. Making of a "water lens," using two medium sized watch glasses, some sealing wax and water. This water lens can be used to start a fire, magnify objects and to take pictures in place of a regular camera lens.
7. Making of electric motors and dynamos out of paper clips and thumbtacks, to illustrate all the necessary principles underlying these topics. These simple devices are actual working models and can be made without any special knowledge or preparation.
8. The freezing of mercury by use of carbon dioxide snow.
9. The making of "density balls" that float in cold water and sink in warm water.
10. Cartesian divers made from glass bulbs blown by pupils.
11. Making a variable rheostat out of a lead pencil.
12. Constructing a scale to show that the products of combustion of a candle weigh more than the candle itself.

SOME OF THE DIFFICULTIES INVOLVED IN THE TEACHING OF COLLEGE CHEMISTRY

BY KIRBY E. JACKSON
Vanderbilt University, Nashville, Tennessee

In 1921 Sy[1] found that the average ratio of students taking chemistry, physics and biology, in high schools in Buffalo, several other large cities, and smaller cities to be as follows:

	Chemistry	*Physics*	*Biology*
Buffalo	1	3.5	5.5
Other large cities	1	1.7	3.7
Small cities	1	2.0	7.0

Undoubtedly there are several reasons for the low ratio of chemistry to the other sciences. In many places the chemistry laboratories are poorly equipped, and good chemistry teachers are not always readily available for high school. But, in his opinion, the main reason why chemistry is not more popular, is the fact that we teach a more or less obsolete and unnecessarily difficult content of the subject.

The question whether students entering college should have had high school chemistry and whether, after in college, they should be given separate courses are questions which have long been discussed, debated and written about but even today we are not of one opinion. According to Hill:[2] "The proper correlation of secondary school and college chemistry courses has never been a simple matter. Many secondary school teachers feel that the colleges expect, perhaps require, far too much of the entering student, while, on the other hand, some college instructors pay so little attention to secondary school courses that they put beginners and students presenting chemistry for admission to college in the same class. Most educators are agreed that unless the secondary school student is given credit for his earlier work in some way or other he is subjected to an injustice. If the college course for those presenting chemistry presupposes a knowledge equivalent to that called for by the college examination board syllabus and students are demoted to a simpler course if they cannot maintain the pace, the well-prepared student will be enabled to profit by his training and the handicap of deadwood be removed from the course."

Stafford[3] is of the opinion that the general chemistry course as taught in college is in all essential respects the same as is

given in secondary school, "Disregarding for the moment what the course is and how it got that way, every one knows that secondary school teachers obtain their training in the college course and then proceed to pass it out to their students in the identical form in which they received it, aided and abetted by the fact that a college man wrote the secondary school textbook." Glasoe[4] registers a similar complaint, "I still insist that most of our college texts for first year chemistry are merely high school texts "grown up" to become young encyclopedias. The chapter and paragraph headings, illustrations and experiments are the same."

As the result of having taught college chemistry for considerably over a decade, the author ventures to express his opinion, which is by no means original, that the student who has finished high school and comes to college without having had a course in chemistry should not consider himself, nor be looked upon, as handicapped. For those students who plan on going to college and whose going is assured, sharing the views of Edmister,[5] he would like to see them spend more time upon arithmetic and algebra and leave chemistry to be taken in college. The results at the University of North Carolina were found to check quite closely with those obtained at Syracuse[6] viz., *that the high school grades in mathematics gave a better index to the ability of the student than the grades in high school chemistry.* But for those who are uncertain and those who are positive that they are not going to college then require them to take the high school course for there is truth in the proverb that "better halfe a loaf than no bread."

Not infrequently a high school teacher finds himself selected to teach a class in chemistry along with that subject he is interested in, qualified for and fitted to teach. This might be due to any number of causes but whatever they might be it is the student who suffers in the end. A teacher finding himself in such a predicament usually does the best he can, for "the show must go on," but that is not enough as he is unable to handle the subject in such a way as to instill into the students under him the enthusiasm and fire them with the interest and desire to continue farther into this limitless subject upon reaching college. Silverman[7] thinks that the employment of a greater number of mature and experienced teachers will not only raise the standard of instruction but will yield even better results. According to Hopkins,[8] "A good teacher is the most important

factor in any chemical course of study. Expensive laboratories, elaborate equipments, costly reference libraries, superior textbooks, and skillfully arranged courses of study are of little value in the teaching of chemistry unless they are presided over and administered by the mind of an individual who knows and loves chemistry, and who has some skill in the science and art of imparting his knowledge to others." Kendall[9] along this same line says: "After all, the primary duty of the teacher, whatever his subject, is to train his students to think for themselves and to reason systematically." Irving Langmuir, on receiving the Perkin Medal, among other things said, "In looking back on my own school and college days, it seems to me that the things of most value were learned spontaneously through interest aroused by a good teacher, while the required work was usually uninteresting." Butler[10] thinks that nothing can so quickly or surely kill any subject of instruction and deprive it of its influence as an educational instrument as an uninspiring teacher or the stubborn insistence upon false methods.

In no few instances the well qualified and enthusiastic high school chemistry teacher finds that the equipment is not such as will permit individual or even small groups doing the experimental work themselves so the demonstration method is resorted to or else no laboratory work is given. In either event the student is unable to become familiar with his working tools so that should he go to college, even though his record bears evidence of his having had a course in chemistry, he is handicapped. Bowers[11] quotes Dr. Charles Eliot, "The need of laboratory work is to train observation. In olden times they got it through hardships. Now they need it because memory work is emphasized too much and scientific observation not enough. The laboratories give men of capacity opportunity to develop them." It takes time and perhaps burnt fingers before one learns how to correctly bend and draw out glass tubing; experience is required to fold and correctly fit filter paper into a funnel; more than a single cork is spoiled in learning how to bore a hole straight through it yet all these operations are quite simple compared to some which the chemist is called upon to perform in the course of a day's work. Clarke[12] says, "One of the things which has often struck me most forcibly in watching the work of young chemists fresh from the university, is their apparent inability to employ the apparatus at their disposal to the best advantage. The laboratory instructor would not be wasting his time if

he spent the first hour in demonstrating the use of the chemist's hardware." Noll[13] found that when two groups very similar in all respects excepting the amounts of time spent in the laboratory were compared as carefully as was found to be possible the section having the greater amount of laboratory work showed consistent superiority in general achievement.

Despite the views of the above, which are just a few which might have been cited, there are those who hold other views regarding the value of laboratory work in the chemistry course. Bowers[14] realizes the importance of laboratory work for the beginner but holds that whether he does the work himself or sees it performed by another makes no difference. Smith[15] favors the teacher-pupil demonstration in which two pupils conduct the experiment while the rest of the class gather around the laboratory table to watch and think under the direction of the teacher. Nichols[16] questions the value of individual laboratory work as now largely conducted. He does not suggest a discontinuance of laboratory work but rather that the work be changed so as to arouse in the student, in so far as the resources of the school permit, the desirable qualities generally considered as its purpose. He offers nothing by way of a solution though. Long[17] has broken away from the time-honored procedure of simply keeping a laboratory notebook; the students take what few notes they wish and the conclusion of each laboratory period a short written quizz is conducted which covers the work just completed in the laboratory. Horton[18] sees in the problem method a departure from the old stereotyped method which works successfully in Seward Park High School (New York City). This method bears careful study for a more extensive adoption not only in high schools but in colleges as well. Downing[19] is of the opinion that the lecture-demonstration method of instruction yields better results than the laboratory method in imparting essential knowledge and is more economical of time and expense. Cooprider[20] estimates the saving in time to be about 50% and Anibal[21] estimates that to teach chemistry to a class of 30 pupils by the lecture-demonstration method costs about 7% as much as the laboratory method. Lucasse[22] is of the opinion that college and university courses designed for students not specializing in the subject might be modified to include less or even no laboratory work to the benefit of all concerned. Thus we see the views of some of those competent to judge the worth of laboratory work in chemistry varying from

those who place a great deal of emphasis upon it to those who would just as soon eliminate it from the curriculum.

Numerous high school and even some college chemistry teachers require their students to become more or less proficient in the art of drawing as they require a sketch of the apparatus used in each experiment. Others have their students memorize atomic weights, dates of discovery and names of discoverer, boiling points, specific gravity, etc., instead of teaching them to "use their heads." If the student knows Boyle's Law for instance, it should not be necessary that he have to substitute numerical values in a memorized formula in order to ascertain the new volume of the gas. It so often happens that the student has memorized one of the numerous expressions which correctly represent the mathematical truth of the law but so often he substitutes incorrectly and somewhere before the answer is obtained an error has crept in. If the pressure on a certain volume of gas is increased he should know instantly, if he really knows Boyle's Law and has not just memorized the definition, that the volume is decreased without taking the time and going to the trouble of setting up the formula, assigning values for the different terms, substituting and then doing the necessary arithmetical calculations. Convert the two pressures into a fraction by making the old pressure the numerator and the new pressure the denominator, then multiply by the volume of the gas and the product will be the new volume. In less time than it takes to tell it he should know that if the new pressure is greater than the old that the fraction will be less than unity and so the product will be less than the original volume; conversely, if the new pressure is less than the original pressure then the fraction will be greater than unity and the product will be greater than the initial volume. So, one should know relatively the answer before one's pencil touches paper. For example, *if a certain gas occupies a volume of 10 liters at 750 mm. pressure what volume will it occupy at standard pressure?* The new pressure being greater than the old the fraction is less than unity or, 750 (the original pressure) over 760 (the new pressure) and when multiplied by the original volume the product should be less than the original volume, i.e., less than 10 liters, 9.868 liters to be exact. This method is simpler than the older method and effects such a saving of time and effort that we can hardly go astray in calling this method "Fool Proof." Students who have had no high school chemistry take to it much more readily

than those who have, the latter are too dependent upon their "crutch." This is just one of the many things which might be mentioned which the student who comes to college with high school chemistry credit on his transcript finds hard to overcome; it is so much easier to write on a fresh sheet of paper than it is to have to do erasing and even though the paper is free from marks after the erasure it is never the same.

The question of the value of high school chemistry to those students who subsequently take the college course has never been settled and probably never will be for the "yard stick" by which such is evaluated varies with the individual making the determination. Much has been written on the subject of whether students entering college with high school chemistry should or should not be given separate courses in the subject. The Committee on Chemical Education made a report[23] on the correlation of high school and college chemistry. In this preliminary report the following points were made:

1. The teaching of chemistry in high school should be encouraged.
2. Such a course should be given in high school that will answer for students who go to college as well as for students who do not go to college.
3. A new course in chemistry must be outlined for the high school, taking into account both content and method.
4. Colleges must recognize high-school chemistry, at least to the degree of having a different course for those students who have had high school chemistry.

Some instructors follow the fourth suggestion to the point of segregating the two groups but when that is done all is done for not infrequently the same lectures are given to both sections and a little or no difference is made in the laboratory work. Despite the recommendations of the committee Fry[24] is of the opinion that a college course could be given that was suitable for all high school students whether they had had chemistry or not. The author concurs with Holmes[25] who thinks it best to segregate the two groups if possible but in small institutions where such an arrangement cannot be carried out he sees no harm done where the same instruction is given for all, as he says, "a certain amount of forceful repetition is the essence of good teaching." Blanchard and Phelan[26] say, "Experience has taught teachers that it is unwise to count too much upon an understanding of studies previously studied. Therefore, although this book is presumed to outline a course continuing from a previous

course in high school, it was thought best to include the essential material of the high school course." However, when all students receive the same instruction it is to be expected that some of the students who have had a previous course in chemistry will be imbued with a kind of superiority complex considering the college course in chemistry to be more or less a repetition of what they had in high school, and, depending upon acquired knowledge, will do little or no studying at the beginning of the course and, drifting along nonchalantly, find too late that the theoretical discussions have reached a point where they are no longer able to "keep up." The author has successfully avoided some of the aforementioned difficulties by having the students realize at the outset that they are being held individually responsible for a thorough review and redevelopment of the subject matter as it is presented in the college course. It has been found that this end can be attained by frequently giving the class short written quizzes without being previously announced. By such a procedure the student is kept "on his toes" all the time and there is no opportunity for such a thing as flagging interest, hazy ideas or overconfidence.

At Denison University[27] all first-year students are given the same lectures and recitation work but different laboratory work, being shifted from one section to another according to their "demonstrated ability." Brown[28] and Silverman[7] found that a separate course should be given to students who had had high school chemistry for in such groupings the percentage of students doing superior work was found to be increased and the number of failures were much reduced. Competition has been said to be "the life of business" and it also plays no small rôle in the school room for where there is competition better work can be expected and where students are carefully grouped according to their proved ability much better work can actually be obtained. At the University of Tennessee[29] it was demonstrated that where one course is given for all first-year students, those with high school chemistry made a better record during the first part of the work but that students with no high school chemistry excell during the latter part of the course. At the New Jersey College for Women[30] it was found, over a five year period, that students with high school chemistry made a better first-year record than those without. It is, of course, impossible to say definitely what the reason for this difference is. It may be that the students who elected chemistry in high school may be

more intelligent or may exhibit greater aptitude for chemistry than those who did not take the course. Hines[31] reports that at Northwestern, where a separate first-year course is offered for students who had had high school chemistry, the first-year course with respect to the percentage of students who pass was approximately the same for the two groups, but that those who had had high school chemistry made slightly better grades in the advanced chemistry courses. Steiner[32] found at Oberlin that students who had had high school chemistry were approximately three times as likely to continue as students of the subject as those who had not which seems to confirm the supposition advanced by Gerard and Gates[30] above that the students early exhibit an interest in and aptitude for the subject.

Haynes[33] shows that only about 10% of the students at ten of the leading colleges and universities who take the first-year course in chemistry follow it with any other work in the subject. Powers[34] has found as the result of tests on 10,000 students that the information imparted to the students in our present courses is largely forgotten.

For the most part those students who elect chemistry in high school can be placed in two general groups: (a) those who need it for professional purposes and (b) those who see, or who have pointed out to them, the value of chemistry as a cultural subject. In the case of that student who intends to go into pure chemistry, physics, biology, medicine, or into any other field which uses chemistry as a building stone there is little criticism to offer for most colleges and universities teach chemistry pretty well from that point of view. It is the other group who need our attention and it is to them that we will devote our time and thought throughout the remainder of this paper for concerning them the problem is much more acute.

At the New Mexico State Teachers' College[35] it was found through *environmental chemistry* that the fundamentals of chemistry could be taught in close relation to the students' environment. This was accomplished by teaching more subject matter from science journals and popular magazines. This method stimulated interest and motivated the class to study fundamental laws and theories which, in the end, stimulated previously indifferent students to take an interest in the work and grades showed that the quality of the work was as good as for previous classes taught in the traditional way. Using the modified physics approach (electronics, x-rays, radiation and radio activity), in-

stead of the old classical method, Wendt[36] used the concepts of atom and atomic structure as the basis for the periodic system, valence and chemical reactions. Such a course involves much more physics than the standard course and requires good lecture experiments but not individual laboratory work.

Bancroft[37] was of the opinion that the course in general chemistry did not cover enough ground to be of real value to the student seeking general education as it went into far too much detail for him. "The better it is as a professional course the worse it is as a cultural course. What we need as a cultural course in chemistry is a course which will cover all the ground given in the universities without going into too much detail. This means a series of popular lectures covering the whole field of chemistry as well as it can be done in the time. . . . It will teach them about chemistry and will give them an interest in chemistry which will stay with them throughout life." As a result of his pioneer challenge others have come forth with their views: Bawden[38], Sampey[39], Timm[40], *et al* have offered suggestions for the organization of the work and planning of such a course for those non-scientific students who have gone into chemistry for the cultural training to be received. Such a course has been designated by Bancroft by the term *Pandemic*. Brinkley[41] reminds us that "the topic *pandemic chemistry* was the subject of a symposium held at the Swampscott meeting of the American Chemical Society. One who has followed this discussion is impressed by the utter lack of agreement among the advocates of these special courses. It would appear that a clear definition of the purpose of such a course is lacking, so that each one devised a course which differs in content and objectives from those devised by others. There seems to have been agreement on only one point; viz., that the existing courses, which they choose to call traditional courses, are so unsatisfactory that the hope is to discard all previous experience in this field and make a fresh start."

After examining the series of topics which Bancroft proposes discussed in 76 popular lectures very little, if any, correlation is found to exist in any two consecutive topics. Such a course would necessarily be very superficial, it would have to be to "cover all the ground given in the universities" in one year and it would be exceedingly difficult to teach applications of chemistry until after the student had established a foundation of fact and theory upon which to build. Stafford[3] would "cut the

Gordian knot" by doing away with the one-year chemistry course as it is now most generally given in our colleges and universities and in its stead would introduce a survey and orientation science course down in the grades which would continue throughout secondary school; a more unified, coherent, progressive treatment of subject matter over a period from 4 to 6 years. Time will permit no farther citations as to the means which have been introduced to solve this problem for the other suggestions which have been proposed are as lacking and impractical as those criticized.

It is with hesitation that the author offers a suggestion toward remedying the non-scientific chemistry course but he will venture to anyhow; he would like to see a course developed that would give the non-scientific student, in a very general way, a broad outline of inorganic chemistry with just enough of the basic theories, devoting not too much time to the mathematical, which would permit laboratory work to be done in qualitative analysis, the rest of the time in the lecture hall, class room and laboratory be spent in the field of organic. Unlike the course outlined by Bancroft such a course as we propose would teach the student some chemistry in addition to teaching "about chemistry," would not cover such a scope and in addition would have laboratory work, whereas in his proposal nothing was said about laboratory work, no provision was made concerning this important part of the course. According to Haldeman[42] "the first-year course is not complete without definite laboratory work for the student." Sampey[39] admits that the laboratory work in pandemic chemistry presents the most difficult problem in the development of chemical education. From ¼ to ⅓ of the laboratory work in such a course as developed at Howard College consists in inspection trips to a number of the industries which so plentifully abound in and around Birmingham. The same criticism is offered here that was applied to the course outlined by Bancroft, viz., that the student hasn't enough of the foundations and theories of chemistry to be able to apply them and get the most from practical applications and the same course could be given by the same instructor in but a few other cities in the United States for but few cities are so fortunate as to have such a variety of industries in their midst as does Birmingham. We agree with Kelsey[43] who says "Analytical work demands greater continuity of effort and more sustained attention to details than any other course given in

the average college curriculum. The pupil soon learns that what he does at one point in his work is significant not only in itself but also in its possible effect upon the work which follows. He must be on the alert all the time and follow things through to the finish if he is to be successful. Another distinctive feature of qualitative analysis is its automatic emphasis upon the value of system and accuracy of procedure. Slipshod work brings its own inevitable penalties, systematic and careful work reaps its sure reward in the satisfaction which comes from the correct solution of a concrete problem. In qualitative analysis the pupil is independent in his laboratory work to a greater degree than is possible in most science courses. Each student is working on a problem of his own and must stand or fall on his own efforts. In the nature of things he must do his own work and draw his own conclusions. Every "unknown" is a challenge to his ability to follow up clues, gather evidence and draw conclusions as does the sleuth in the detective story." Thus from such a course early in his college career, the student acquires habits which prove beneficial to him throughout not only the remainder of his academic studies but which become invaluable throughout the rest of his natural life.

It is to be deplored that so few people, even a relatively small percentage of the students in college and university, are acquainted with *organic* chemistry. So, in this course being proposed, it is suggested that some time be spent in the organic field; that lectures be given and topics assigned for outside reading and study bearing on the many applications and principles of this most important phase. No branch of chemistry, or any other science, comes closer to life itself than organic for, when Jacques Loeb demonstrated that the fertilization of a sea-urchin egg could be brought about by a drop of chemical being placed in the water bathing the egg instead of a sperm, he showed unmistakably that life itself at the very beginning was connected with chemistry.[44] Life itself is an organic chemical process, the body cells being individual laboratories. Practically all the food we eat, the raiment with which we clothe and protect ourselves, the fuel by which we propel ourselves over the earth's surface and through the air and water and by means of which we are kept warm are all of an organic nature. The process of fermentation, tanning, the synthesis and manufacture of dyes, explosives, soaps, anesthetics, perfumes, disinfectants, drugs and the thousands of

other just as important products and processes have to do with the organic phase.

LITERATURE CITED

(1) *J. Chem. Education, 1,* 25 (1924)
(2) *Ibid., 6,* 914 (1929)
(3) *Ibid., 7,* 565-70 (1930)
(4) Paper presented at the Denver Meeting of the Division of Chemical Education, Aug. 1932
(5) *J. Chem. Education, 7,* 2154 (1930)
(6) Scofield, *ibid., 7,* 117-26 (1930)
(7) *Ibid., 5,* 317-22 (1928)
(8) *Ibid., 1,* 35 (1924)
(9) *General Chemistry,* The Century Co., New York City, 1927, p. vi.
(10) Annual Report of the President, 1925, Columbia University, New York City
(11) *J. Chem. Education, 1,* 206 (1924)
(12) *Ibid., 4,* 1009 (1927)
(13) *Ibid., 6,* 1740-47 (1929)
(14) *Education, 44,* 546 (1924)
(15) *J. Chem. Education, 2,* 231-4 (1925)
(16) *Science, 74,* 152 (1931)
(17) *J. Chem. Education, 7,* 1642-4 (1930)
(18) *Ibid., 6,* 1130-5 (1929)
(19) *School Review, 33,* 688-97 (1925)
(20) *School Science and Mathematics, 23,* 526-30 (1923)
(21) Master's Thesis, University of Chicago, 1924, p. 69
(22) *J. Chem. Education, 5,* 142-50 (1928)
(23) Secretary's Report, *Ind. Eng. Chem., 15,* 534 (1923)
(24) *J. Chem. Education, 2,* 260-9 (1925)
(25) *Science, 56,* 648 (1922)
(26) *Synthetic Inorganic Chemistry for First-Year College Students,* John Wiley & Sons, New York City, 1922, p. iii.
(27) Everhart and Ebaugh, *J. Chem. Education, 2,* 770-3 (1925)
(28) *Ibid., 3,* 301-6 (1926)
(29) Buehler, *ibid., 6,* 510-3 (1929)
(30) Garard and Gates, *ibid., 6,* 514-7 (1929)
(31) *Ibid., 6,* 687-707 (1929)
(32) *Ibid., 9,* 536 (1932)
(33) *Science, 65,* 462 (1927)
(34) *J. Chem. Education, 2,* 174-80 (1925)
(35) Graham, *ibid, 8,* 531-3 (1931)
(36) *Ibid., 8,* 281 (1931)
(37) *Ibid., 3,* 396-400 (1926)
(38) *Ibid., 6,* 1808-18; 2033-43 (1929)
(39) *Ibid., 5,* 1243-54 (1928)

(40) *Ibid.*, *6*, 1316-20 (1929)
(41) *Ibid.*, *7*, 1869-75 (1930)
(42) *Ibid.*, *5*, 1278 (1928)
(43) *Ibid.*, *6*, 486-92 (1929)
(44) Jackson, *The Chemist*, 613-9 (1932)

DUST TO FIGHT FIRES

Water may soon be a thing of the past in fighting fires if fire-fighting dust invented by Prof. Frederick K. Kirsten, aeronautical engineer at the University of Washington, and soon to be placed on the market, is widely accepted.

Prof. Kirsten has invented a device by which this dust may be played on a fire in an aerated mass through a hose and nozzle.

The dust smothers the fire by developing a large quantity of carbon dioxide gas under heat.

In a test directed by the Seattle Fire Department, the dust extinguished in three seconds a roaring blaze in a garage filled with oily rags, crumpled newspapers, cedar shingles, oil and gasoline.

The dust does not absorb water, Prof. Kirsten explained. It looks like coarse flour and flows like water under treatment. A pressure of 200 pounds can be put behind it.

A specially designed fire engine provided with the new fire-fighting dust has been in operation for three months at the Washington State Hospital located at Medical Lake, Washington. Dozens of small fires have been successfully extinguished during that period. Prof. Kirsten's latest application of his new principle is the development of a small hand extinguisher.

It has been estimated that 80 per cent of the damage incurred at the time of fire is attributable to the water used in putting out the fire.

The dust, a secret combination of chemicals which produce carbon dioxide immediately upon contacting fire, has been available for several months but the manufacturers needed a device with which to project it. By means of a hose and nozzle, the dust is played on the blaze under the same pressure as an ordinary water extinguisher and the fire is smothered in record time.

The day of flooded basements, plaster-soaked ceilings, and warped woodwork is passing, says Prof. Kirsten. As he visualizes fire-fighting methods in cities of the future, water will be used only for light sprinkling.

The Zenith Fire Dust Corporation of Seattle are Pacific Coast Distributors for the new fire-fighting dust.—*Science Service*.

A COURSE IN ELEMENTARY SCIENCE FOR SECOND-YEAR CONNECTICUT NORMAL SCHOOL STUDENTS

By Charles Pratt
State Normal, New Britain, Connecticut

In presenting this paper it has seemed necessary to preface the main discussion with a brief review of the Connecticut situation that brought about the attempt to prepare this course of study.

Until the fall of 1930 all Connecticut normal schools were two-year institutions. At that time the state normal school at New Haven admitted students for a three-year curriculum only. New Britain did the same in 1931. In the fall of 1932 the two remaining state normal schools went on the three-year plan which involved a three-year curriculum to prepare students to teach in the kindergarten and the first six grades. This change necessitated the organization of new courses and reorganization of the old courses. For this purpose committees composed of members of the teaching staffs of the four state normal schools were appointed.

A steering committee was appointed to guide and harmonize the work of all the other committees and to determine the courses and the semester hours of each subject. This committee included the State Director of Teacher Training and the principals of the four state normal schools as well as several members of the teaching and supervisory staffs.*

This steering committee allotted to the science department seven of the 96 semester hours of the three-year curriculum with the understanding that three of the seven be given to a comparatively new subject, namely, educational biology, thus leaving only four semester hours to all other science courses.

In the two-year curriculum the science department had only four semester hours all of which were devoted to nature study. The teachers were well aware of the fact that leading educators were including nature study in a course called elementary science and that the physical sciences were being included more and more in the elementary science courses. Moreover, the Connecticut Commissioner of Education had appointed a science committee composed of officials at the state department of edu-

* The Bridgeport City Normal School co-operated with the state in this undertaking.

cation and of teachers in the public schools to prepare a science course of study or series of courses for not only the elementary but also the secondary schools of the state. This committee had decided to include much physical science in the science course for the first six grades. Since this was true and since the normal schools' work is to prepare its students to teach in the kindergarten and first six grades, the normal school science committee decided to devote only two of the four semester hours to nature study and to utilize the remaining two semester hours in a course full of physical science which they called elementary science.

Connecticut normal schools, for many years, have considered nature study and elementary science as separate subjects rather than one as is now considered by some educators. Nature study included all study of living things, especially their appearance, habits and uses. Its chief aims were the worthy use of leisure time, the economic value of living things and the conservation of the helpful, and the scientific method. Elementary science included all studies of inanimate things, and emphasized the principles of physics and chemistry involved in those things. Its chief aims were scientific method, logical reasoning, vocational guidance or stimulus and the scientific explanation of common phenomena and inventions.

For years, up to about 1915, Connecticut normal schools had been strong advocates of a rather formal presentation of elementary science, that is, principles of physics and chemistry, in all the grades from the first through the eighth. Many cabinets of apparatus for simple physical and chemical experiments and their respective detailed lesson plans had been prepared and loaned to schools by the state board of education but they apparently never met the situation or the needs adequately.

Because of the inability to secure sufficient apparatus, noticeably in the rural schools, and because few teachers at that time could be found who could teach the principles, with their applications, the normal schools began to emphasize nature study the materials of which were always at hand and the understanding and presentation of which were easier for the teachers especially since the Connecticut nature course was not graded. Being suggestive, rather than mandatory, permitted the teacher to teach the pupils that part of the environment which the pupils desired and which she herself knew and liked

best, provided it had not previously been taught in the lower grades and also provided that she hand on with her class to the next teacher a written account of their nature study accomplishments during the period she had been their teacher.

Until about 1915 the Connecticut normal schools taught a science principle and then applied that principle to many common things. Now these same normal schools plan to start with the things themselves and explain their uses, operations or actions by teaching the science involved in them. In so far as possible, the things used will be those in which the pupils manifest a strong interest. What brought about this change?

The science committee's problem was to prepare a course of study in elementary science that would prepare the second-year student-teachers to teach this physical elementary science in the first six grades. This required teaching them the method, as well as the subject matter. The question arose, "Can a course in elementary science be prepared and presented to the normal school students in a manner somewhat like that used in the grades except that it will have to be on the college level, be presented in a shorter time, and, since all the principles and facts cannot be taught in the limited time, initiate habits of study that will enable the student, when a teacher, to take a principle or item new to her, study it carefully, learn its essentials and then guide her pupils as they work its solution out?"

Because the elementary school course of study in elementary science was and still is far from completion, the normal school science committee could get little help from that committee even though two of its members were also members of the elementary school science committees. The most helpful suggestion had reference to the informal method of presenting elementary science in the first six grades. Perhaps it was well that a complete course was not available. Such a course might have limited rather than stimulated the normal school science committee.

Another factor that had to be considered was the variable pre-normal school science preparation of the normal school students. Although prospective normal school students are carefully selected in Connecticut they are not required to have had any science. As a result fully twenty per cent of the students have had no science, many have had only general science, quite a number have had general science and physics or gen-

eral science and chemistry and only a few have had general science, physics and chemistry.

Since all students were required to take the same courses, such extremes in pre-normal science preparation presented a serious and difficult problem. The students with no science preparation would have a discouraging handicap at the outset. At the same time students with even some preparation would have been over the ground by either the problem method, the unit method, the traditionally college preparatory method or some other method. To require these students to take again this subject in a similar method would perhaps be deadening, disheartening and destructive of good habits and attitudes. Moreover, it would have been unjust to them unless something vitally new were included in the course.

The committee, however, even with this knowledge tried to adapt some of the current methods of presenting elementary science, particularly that of large units. It studied the latest texts and reports and consulted students as to the books and methods they had used. It even tried to make special units for the course but each attempt presented a situation that would neither be fair to the prepared student nor present the material in the manner proposed for the grades. In other words, it would not have been professionalized satisfactorily.

The light came to the committee while trying to discover from Mr. Russell F. Lund, then the Connecticut State Supervisor of Elementary Science and Nature Study, what science his committee planned to teach in the grades and how they planned to teach it. He emphasized and re-emphasized the value of beginning with the pupils' interests, with that which they want to know, with that which naturally fits in with their units of work in other subjects such as social studies and with that which enriches their present living. Almost to a man the committee said, "This is the key to the answer to our problem." Later some members had their doubts and time and time again they, through old habits, drifted away from this key idea until the variable pre-normal science preparation difficulties and overlapping topics submerged them in what seemed to be insurmountable obstacles. Much work brought the committee no nearer to its goal until the key idea was firmly established and strictly adhered to, namely, to teach the science that the normal school students believed they wished to know about things in their own world.

The work of the committee and how the experimental course is working in the normal schools can be but briefly considered here.

Since the course was to be based on those things or items in which the normal school second-year students had greatest interest, it was necessary first to discover what those items were and second to agree upon the method of treatment in a class with such varying pre-normal science preparation.

In order to discover those things in which the prospective students had greatest interest a questionnaire listing 370 items requiring some science for their comprehension was prepared, administered and the results tabulated.

The items used were selected by members of the committee and by their students, listed alphabetically and sent to the chairman who made a master copy of all the items that required some physics or chemistry for their explanation. An effort was made to secure the names of all the most common items especially those important in Connecticut.

The questionnaire consisted of these 370 items listed alphabetically with a space at the left of each item in which the student could indicate her interest. The directions at its beginning were as follows:

Science Interests of Connecticut Normal School Freshmen

In the blank space at the left of each item listed below indicate by the figures 0, 1 or 2 how great your interest is in the science involved in its scientific explanation.

0 means "little or no interest," 1 means "some" interest and 2 means "much" interest.

The science involved in the items may have to do with their manufacture, development, preparation, operation, care or use.

Some of the items were television, radios, X-Rays, telephones, movie camera, aeroplanes, cosmetics, automobiles, antiseptics, microphones, submarines, fire, fire extinguishers, lenses, etc.

This questionnaire was filled out by each of the 369 freshmen in the four Connecticut state normal schools during January 1932. In most schools this took the place of a regular class assignment thus securing greater care and control. In all cases the students' interests in and attitude toward the questionnaire were made real by discussing with them the committee's problem and by pointing out to them the vital relation between the results of the questionnaire and the students' science work dur-

ing their second year. They were made to feel they were helping to prepare their own course of study, the success of which depended largely upon the care with which they considered each item. To secure a true expression of interest it was stressed that no student's questionnaire would be used against her in any way. The students were encouraged to discuss the items with one another, to consult their instructor and to use reference books for the purpose of understanding the meaning of the item, but to a record only their own personal interest regardless of the interest of other students.

Each member of the committee, with the help of his students, summarized the scores for each item and sent those summaries to the chairman. From the five summaries the chairman made a total summary for each item. A summary for any item simply consisted of the total count of its scores by the 369 students.

After the summaries had been made the chairman found for each item its per cent student interest by proceeding as follows:

The highest score any individual student could give to any item was two. The total number of students who filled out the questionnaire was 369. Therefore, the highest possible score for any item would be 369 times two or 738. Since acetylene gas received a total score of 130 its per cent student interest would be 130 dividend by 738 which gives .176 or 17.6 per cent. In a similar manner the per cent student interest was found for each item. The raw scores were changed to per cents so that the amount of interest could be comprehended more readily.

The items were then arranged in order of their per cent student interest from the highest to the lowest, duplicated and sent to each member of the committee. The highest was 79.1 for television and the lowest was 11.2 per cent for the barber's chair.

The question arose as to whether a study of these items would include all the essential science principles and facts that the committee had estimated as desirable through the analysis of the new elementary school science books, Knight's elementary science chart and recent articles or reports connected with this problem. By means of a rough analysis of the items it was found that there were 87 items for science of the atmosphere, 161 for chemical processes, 102 for electricity and magnetism, 97

for heat, 38 for light, 204 for matter, energy and machines, 24 for sound and 55 for water. These facts removed any doubt as to the amount of science involved. In fact it convinced the committee that there was too much science for a two semester hour course and it would be necessary to eliminate many of the items with a low per cent student interest. Up to the present writing the amount of elimination has not been determined.

In considering the method of class treatment of these items the committee at first was strong for big units in the larger fields of science indicated above in the rough analysis. Each member was to prepare a unit in one field only, that is, in the field of sound, of electricity and magnetism, of light, of heat, of atmosphere, of water or of chemical processes. In preparing each unit the following steps were to be followed.

First, select from all the items listed those items related to the field of science for which the member of the committee was to prepare a unit.

Second, arrange these selected items for a given field, such as "sound," in order of per cent of student interest from the highest to the lowest, recording at the left of each item its per cent of student interest.

Third, elaborate step two by stating in one, two, three order and in simple complete declarative sentences under each item the principles and facts involved in its explanation.

Fourth, build the unit for the field around the items selected that had the highest per cent student interest beginning with the highest item selected.

Fifth, each unit, such as the unit on "sound," was to be composed of many problems each of which centering about an item involving principles of sound, of outcomes expressed in terms of principles, attitudes and habits for each problem and of a bibliography for each item.

The difficulties the committee met in forming these were the continual overlapping (a majority of the items might correctly be considered as belonging to two or more of the large fields of physics or chemistry), the divergence from the informal elementary school method and the adherence to a method already familiar to the students with pre-normal science preparation.

The committee finally agreed that their major difficulties were due largely to the fact that they were attempting to unify two different methods of presentation, namely, the one in which emphasis would be given to a unit full of problems all in the

one big science field, such as the field of sound, and the other in which the principles of any necessary science field might be used while considering any given item such as television. Many of the difficulties would disappear if any item itself were considered as a unit with many problems and the class encouraged to use any science principles essential to a clear understanding of the item under consideration even though such principles were those involved in the explanation of other items with lower per cent of student interest.

If, for example, the item "television" were considered as the first unit because of having the highest per cent of student interest, it would require for even a fair understanding of its operation most of the principles involved in such items as nature of light, mirrors, lenses, speed of light, electric light, electro-magnet, transformers, radio transmission, radio reception, moving pictures, dynamo, dry cell, storage battery, electric wiring, electric circuit, electric insulators, electric amplifiers, electric eye, electric switches, electric fuses, electric transmission, telegraph, telephone, electric motors, theory of electricity, theory of all matter is electricity, water power, induction coils, etc. The need for the understanding of the principles required in these items would be a felt need and each need would be felt in turn as the big television unit would be unfolded. This means that each principle of these other items in the television unit would be motivated naturally because of this felt need as well as because of its higher per cent of student interest expressed in the questionnaire.

As a result of this committee agreement the tentative unfinished course has been used in some of the schools since November 14, 1932 as an experimental course. It consists of the list of items arranged in order of per cent of student interest, outcomes expected expressed in terms of principles, habits and attitudes and a bibliography of only the latest books. Each instructor who is using the course is attempting to discover the best method for classroom treatment. At times committee meetings will be held for the purpose of pooling results. In due season these results may be organized as a part of the elementary science course for normal school students.

The past six weeks' experience with the course has brought to the attention of the teachers certain defects and certain advantages of the course or the method used.

First, since about half of the students live in the dormitories

and seldom go home over the week-end, it is not practicable to depend too much on the method used in the grades of having the students prepare or secure at home simple apparatus for experiments to present to their classmates or bring from home books, magazines and other illustrative or helpful materials. The recognition of this limitation should not prevent those who do commute from using this elementary school method. The limitation does, however, emphasize the importance to the instructor of having prepared ahead of time, for each principle that may be needed by the students, the necessary but simple apparatus or equipment that is an essential feature of the course.

Second, with the home or school equipment ready when the need is felt, either a student or the instructor may present the experiment to clarify the point under discussion. In either case other students would be encouraged to help in the presentation. This provides a natural and excellent opportunity for the pre-normal prepared students to utilize their high school preparation as a teacher by actually teaching a real lesson to at least half of her division. Such procedure professionalizes the course and recognizes the prepared student's advanced standing thus enriching the class concepts and putting new and professional meaning into the old material for the student. The extent to which students, rather than the instructor, may present the illustrative experiments has not been fully regulated yet. Some natural limiting factors or criteria for answering the problem involve the amount of student pre-normal preparation, to what extent the student participated in securing the equipment, the ability of the student to present lessons effectively, the complexities and dangers of the experiment, the economy of time and to what extent the presentation would be like that required in the grades.

Third, although the interest for all students may be keen at the outset yet the student with little or no pre-normal science preparation may lose interest soon if her reading is not carefully directed. The complexity of her problem at first would overwhelm her. The instructor must recommend for such students the simpler books to give them an elementary background and organize for them a list of topics in a good order for logical reading or study. Later these students may become leaders in their divisions.

Fourth, since the same principles have to be used over and

over again in learning the science or the explanation of other common things or items, a natural review permeates the daily, weekly or term work—it is unavoidable.

Fifth, the method of presentation can readily be similar to that used in the grades where the students will eventually teach. A unit may even grow out of a unit in another subject in the normal school but dependence cannot be placed on such cases happening often. What can be depended on is one science unit leading to another.

Sixth, the length of the course in terms of topics or subject matter or number of items has not been and probably ought not to be attempted or pre-determined for each class. Such a pre-determined limited, required amount would be opposed, to a considerable extent, at least, to the method used and undoubtedly would bring about difficulties with reference to interest and natural procedure from one interest to another. Since the main aim cannot be the presentation and the learning of all the science the teacher may have to teach or use in teaching—an impossible task in the short time—it seems better to take time enough for each unit to teach the student first of all how to study and prepare to teach the science involved in an item, to learn how to do what she will be compelled to do when she becomes a teacher by practicing that very kind of activity while in normal and at the same time learn as many science principles as can be learned naturally in the units that may be considered.

Seventh, at least the committee has begun a presentation and a course that is not like that of the high schools attended by the students. It may be new; it may be good; it certainly is different. This difference may preserve the interest and respect of those students with pre-normal school science preparation and at the same time utilize the interests of all students.

From the experiences up to the present time it seems probable that a course in elementary science can and will be prepared and presented to the second year Connecticut normal school students in a manner similar to that proposed for the grades.

In conclusion, it must be evident that the interests of the students have been considered an asset both in the selection and the teaching of the material of the course, that the individual differences in ability and preparation are being recognized, that the course is flexible and that the work has been profession-

alized but that the course is far from complete. Much remains to be done to have it even approach perfection. It is hoped that because new lists of items will be prepared from time to time and presented in the manner suggested the course will be a live course and permit every student to live while learning.

PURPOSES MASKING BEHIND THE ECONOMY CRY

From an Address by DR. GLENN FRANK

(1) The determination of a discredited economic leadership to shift the blame for the depression to the shoulders of government and thus to divert public attention from its own muddling mismanagement of the national enterprise.

(2) The determination to cut governmental expenditures to a point where incomes and inheritances will not face further tax drafts regardless of how drastic the drop in revenue from property taxes may become.

(3) The determination to stop by starvation extension of governmental activity, to compel government to return to the simpler rôle of simpler days, leaving to the leadership of private interests an unfettered freedom to reënact the ventures in irresponsibility that landed the nation in economic disaster and may land many of the idols of yesterday in jail or in exile.

In a time when honest economy is imperative, it is not, I know, popular to direct attention to these ulterior motives that parade in the borrowed livery of honest economy, but upon their exposure now the future health of the national enterprise will depend. And no group in the nation stands to gain more from such exposure than the realistic, honest, and socially minded leadership of American business, industry and finance.

POISONOUS CYANIDE COPPER-PLATING PROCESS REPLACED BY NEW SAFE METHOD

The cyanide bath now widely used for copper plating of steel can be replaced by a new non-poisonous electroplating solution developed by Dr. Colin G. Fink and Chaak Y. Wong of Columbia University, New York.

A complex copper salt, chemically known as disodium diaquodioxalatocupriate, is used in the new bath, along with sodium sulphate and boric acid.

The new method will be available for use in large automatic plating installations where strip steel, standard steel parts, etc. are coated with copper as the first step to other coatings. A satisfactory copper deposit is obtained in only one minute with a low electrical current density with the new "oxalato" bath.

The copper cyanide bath is used in electroplating copper upon the more electronegative steel because from it the copper is not deposited by replacement in a loose, non-adherent film as it is from a copper sulphate solution, for example. But there are serious drawbacks to the commercial cyanide bath. It is very poisonous and the hydrocyanic acid formed when acid acts upon the metal cyanide is still more poisonous. Very careful operators must be employed. The cyanide bath is also unstable and deteriorates with use.

Dr. Fink expects the new oxalato bath to come into commercial use because of its lack of poisonous properties and its relative stability.—*Science Service.*

A COMPARISON OF TWO METHODS OF TEACHING FIRST YEAR HIGH SCHOOL ALGEBRA

BY RICHARD EDW. GADSKE
Carbondale, Illinois

Educational research is in its infancy in all types of individualized techniques; and one of the major fields for investigation is the analysis and testing of general and specific methods. The purpose of this article is to report the results of an investigation relative to the effectiveness of teaching first year high school algebra by two different methods, the individualized unit method and the traditional group method.[1]

The data in this report were secured from the freshman class, of approximately one hundred pupils, in the Community High School at Carbondale, Illinois, during the school year 1931-1932. About half of this class was equated into two groups: an Experimental Group and a Control Group. The two groups were selected on the basis of the results obtained from standardized tests of intelligence, arithmetic ability, reading ability, and the results reported in a survey by Symonds[2] of similar factors. The data for determining the relative algebra achievement of the Experimental Group as compared with the algebra achievement of the Control Group were obtained from two standardized algebra achievement tests, one form administered at the end of the first semester and another form administered at the end of the school year.

The standardized tests were administered in the order listed:

Sept. 3, Otis Group Intelligence Scale.
Sept. 18, New Stanford Arithmetic Test.
Sept. 23, New Stanford Reading Test.
Jan. 13, Columbia Research Bureau Algebra Test, Form "A," for the first semester. Administered in place of the traditional final examination.
May 25, Columbia Research Bureau Algebra Test, Form "B," for the entire year. Administered in place of the traditional final examination.

The Experimental Group was taught by the unit method in which instruction and progress were strictly individual within

---

[1] Gadske, R. E. *A Comparative Study of Two Methods of Teaching First Year High School Algebra.* Master's Thesis. Northwestern University, School of Education Library, 1932. 99 pp.

[2] Symonds, P. M. "Special Disability in Algebra," *Teachers College Contributions to Education,* No. 132. New York: Teachers College, Columbia University, 1923. Pp. 59-62.

each unit and the assignments were unit assignments.[3] At the beginning of the course each pupil was supplied with a copy of unit assignments covering the entire course. Each assignment covered thoroughly one teaching unit, and covered the following items:

1. It stated briefly and specifically the purpose of the unit.
2. It contained a preview of the unit, that is, several of the fundamental exercises and their solution, representing a sample of the knowledge and skills to be acquired through a study of the unit.
3. It clearly designated the work to be done. This work was laid out so precisely and in such a manner that the pupil knew exactly the pages to be read, the exercises to be solved, the order in which the various tasks were to be performed, and prescribed when the instructional tests were to be taken.
4. It designated definite directions for a thorough review of the unit, which was followed by the Mastery Test of the unit.

Throughout the study of a unit, each pupil progressed through the various assigned tasks according to individual ability. During each unit the pupils were brought together as a group on only two occasions: first, for an introduction or preview of the unit, and second, for the mastery test of the unit. The intervening time was spent by each individual pupil in the performance of assigned tasks, consulting the teacher relative to difficulties encountered inside as well as outside of the classroom, taking the instructional tests, and performing the additional remedial tasks assigned whenever necessary.

As the pupils progressed individually the teacher moved about the classroom giving the needed assistance, examining each individual's work and progress, and finally setting a date when the unit was to be completed. The plan for setting a date for the completion of a unit, as carried out in this experiment, was to carefully observe the rate of progress of the average pupils. The slower ones were then encouraged to do more work outside of the classroom while the hustlers either helped the slower ones, or worked out additional problems involving practical applications of the unit being studied, or studied the operation of a Slide Rule. (The latter two alternatives were selected by the majority.)

The Control Group was taught by the conventional group method. The instruction was group instruction where the pupils progressed as a group through lectures, demonstrations, recita-

[3] Haertter, Leonard D. *Unit Assignments for a First Course in Algebra.* Philadelphia: The John C. Winston Company, 1930. 16 pp.

TABLE I

THE EXPERIMENTAL GROUP AND THE CONTROL GROUP PUPILS LISTED IN THE ORDER IN WHICH THEY WERE PAIRED WITH TESTS RESULTS

Experimental Group						Control Group					
Pupil No.	I.Q.	Arith.	Read.	*Alg. T-No. 1	*Alg. T-No. 2	Pupil No.	I.Q.	Arith.	Read.	*Alg. T-No. 1	*Alg. T-No. 2
93	120	108	101	48	24	9	119	110	105	38	14
6	119	106	104	38	21	51	122	102	105	33	8
70	115	98	106	27	13	4	113	97	102	13	2
78	115	96	94	41	23	56	115	91	90	17	13
63	115	87	104	32	9	67	122	88	109	27	12
11	112	87	97	27	13	101	110	89	92	8	2
58	112	79	104	20	8	69	113	86	109	25	7
38	112	73	96	19	7	3	118	72	112	8	3
35	111	89	104	36	24	25	111	91	99	29	13
90	110	69	108	22	8	62	110	71	88	8	3
98	110	76	97	28	6	99	110	84	90	10	9
34	109	103	105	45	30	92	113	98	97	42	10
44	108	88	110	17	8	55	112	92	100	11	6
5	104	80	107	40	18	57	104	81	96	7	3
48	104	69	88	21	7	41	106	75	112	14	6
36	103	82	81	27	15	73	102	83	81	18	9
49	103	86	93	14	8	64	103	89	92	15	4
97	102	96	94	55	34	85	108	97	94	36	12
10	100	80	80	14	4	82	101	84	96	10	2
7	98	71	75	23	12	31	98	78	74	13	2
72	93	88	86	38	17	95	93	85	83	4	2
42	92	74	77	26	10	81	92	76	83	13	3
27	82	71	86	7	2	84	85	80	76	4	2

* Alg. T-No. 1 (Represents Algebra Test Form A, administered at end of first semester and covers a little more than the first semester algebra).

* Alg. T-No. 2 (Represents Algebra Test Form B, administered at end of second semester and covers a little more than a year of algebra).

tions, daily assignments, tests, and group remedial instruction. There is some individual instruction involved in this method in that the school system operates under the one hour class period, the last twenty minutes of which are devoted to supervised study.

The method of equating pupils for the Experimental Group and the Control Group was based on the group correlation coefficients of the factors such as intelligence quotient, arithmetic achievement, and reading achievement. The writer determined the group correlation coefficients for the entire freshman class as follows:

I.Q. versus Arithmetic .... $r = + .572 \pm .045$

I.Q. versus Reading .... $r = + .783 \pm .026$

Arithmetic versus Reading .... $r = + .466 \pm .052$

The above coefficients correspond very closely to the ones re-

ported by St. John.[4] Symonds[5] found that the coefficient of correlation of Arithmetic ability with Algebra ability was higher than Intelligence with Algebra, or Reading with Algebra. This was later corroborated by the writer in the present investigation.

There was some difficulty encountered in finding twenty-three pupils out of the freshman class of approximately one hundred pupils who would equate, or pair with the twenty-three pupils in the Experimental Group, on the basis of all three of the factors. Consequently they were paired on the basis of Arithmetic and Intelligence, also on the basis of Reading achievement wherever it was possible to do so, i.e., about two-thirds of the cases.

From Table I, the major table of the experiment, one may glean the manner in which the pupils were equated, as well as the difference in Algebra achievement. The pupils are listed in the order they were equated.

Table II represents a summary of Table I from which one may observe the group relationships of the factors involved; including a comparison of the norms for the same factors. The norms listed are those for high school freshmen, or the ninth grade.

TABLE II

COMPARISON OF MEANS, RANGES, AND STANDARD DEVIATIONS OF THE EXPERIMENTAL GROUP VERSUS THE CONTROL GROUP

	Experimental Group				*Control Group*		
	S.D.	Range	Mean	Norm	Mean	Range	S.D.
I.Q.	9.0	82-120	106.5	100	107.8	85-122	9.4
Arithmetic	11.6	69-108	85.0	96	86.9	71-110	9.5
Reading	10.4	75-110	95.5	96	95.1	74-112	10.6
Alg. Test 1	11.8	7-55	28.9	33	17.5	4-42	11.1
Alg. Test 2	8.4	2-34	14.0	16	6.4	2-14	4.2

From the two preceding tables, and others not included in this report, the writer has derived many interesting conclusions. The scope of this report cannot include all of the results which have been obtained. A few of the more outstanding results are as follows:

First: the actual difference between the Means of the Experimental Group and Control Group on algebra test No. 1 is 11.4 and in favor of the Experimental Group. The standard error of difference between these two

[4] St. John, Chas. W. *Educational Achievement in Relation to Intelligence*, Cambridge: Harvard University Press, 1930. Pp. 38-102.

[5] Symonds, P. M. opus cit. Pp. 59-62.

Means is 3.37. The actual difference (11.4) is a little over three times as large as the standard error of the difference (3.37).

The actual difference between the Means of the Experimental Group and Control Group on algebra test No. 2 is 7.6 and in favor of the Experimental Group. The standard error of difference between these two Means is 1.96. The actual difference (7.6) is nearly four times as large as the standard error of difference.

The average pupil of the Experimental Group has not only learned more algebra than the average Control Group pupil, but has also approached, very closely, the norms of the two tests. Furthermore, it is significant to note that the Experimental Group has increased its algebra achievement superiority over the Control Group from Test No. 1 to Test No. 2 (Retest).

Second: the range of the Experimental Group is considerably greater than the range of the Control Group in test No. 1, and even more pronounced in test No. 2. This is only a natural reaction, because the gifted pupils had every opportunity, in the Experimental Group, for achievement to the limits of their ability.

Third: the "sigma," or standard deviation, of the Experimental Group in the algebra tests is higher than that of the Control Group. This difference is far more pronounced in test No. 2. After a brief analysis of this condition one may be led to the conclusion that the pupils of the Experimental Group had more opportunity to achieve according to their ability, whereas the gifted pupils in the Control Group must have wasted a great deal of time to the extent that their achievement was retarded.

The findings of the experiment might be summarized as follows:

1. The differences in achievement reveal a statistically significant advantage in favor of the individualized unit method over the general classroom method.
2. The gifted or superior pupils under the individualized unit method seem to have been challenged according to their individual intellectual capacities and therefore have accomplished more than the superior pupils taught by the conventional group method.
3. The slower pupils show a smaller margin of advantage. They seemed to become less discouraged by the experimental method than by the conventional group method. This was undoubtedly due to the element of fair play and the motive for self-reliance, which seems to be a predominant characteristic of this individualized unit method.
4. The increased superiority in achievement of the Experimental Group from test to re-test shows greater retention for the individualized unit method.
5. The lower quartile of the Experimental Group have a higher algebra achievement according to their ability than the upper quartile. The lower quartile of the Control Group likewise have a higher algebra achievement according to ability than the upper quartile. However, this difference is not so pronounced as in the Experimental Group.[6] (Note:

[6] A portion of the data supporting this statement were secured from a table not included in this report. They were determined statistically from the table on page seventeen of the writer's thesis. opus cit.

this relationship refers to each group in itself. The upper quartile and the lower quartile of the Experimental Group show superior achievement over the corresponding quartiles of the Control Group, as previously mentioned.)

6. The individualized unit method is more efficient, because, (1) it saves time in explaining assignments each day, (2) it saves time for the gifted pupils, and (3) it saves time for the slower pupils. This is due to the fact that in teaching the average pupil by means of daily lectures and recitations, the gifted pupil is bored part of the time and the slower pupil cannot keep up with the class. (Note: the time saved is to be considered from the individual's viewpoint, because both groups completed the course at the end of the school year.)
7. The individualized unit method is adapted to any conventional secondary school system without any need for administrative reorganization.
8. A more intimate and congenial relationship seems to be established between pupil and teacher in the individualized unit method than in the group method.

This investigation is far from being a complete solution of all the relevant problems. It is simply one of many that must be made in order to reach final conclusions concerning the relative merits of individualized unit instruction versus group instruction. The experience of the writer, as a result of his observations during the course of the experiment, seems to suggest defects in the conventional group method that might be improved so as to make it more effective. Nevertheless it seems apparent that some importance may be attached to the findings, particularly since the individualized unit method has turned out so superior to the traditional group method in this experiment.

ELECTRON TUBE DETECTS CONCEALED WEAPONS

An ingenious robot detective that will "frisk" a man for concealed weapons, register the fact that it has found him and take his photograph, all without his knowledge, was described in an address by O. H. Caldwell, editor of the technical journal *Electronics*. The device is built around an electron tube. It can be so delicately adjusted that while it will react to a mass of metal as large as a revolver, it will ignore smaller metallic objects which law-abiding men usually have about them, such as watches, coins and bunches of keys.

Another device described by Mr. Caldwell counts persons passing through an entrance, no matter how fast they come or how much massed in groups. It does not overlook odd sizes and shapes: when Mr. Caldwell tried to fool it by hiding behind an umbrella as he passed it, he got counted anyway.—*Science Service.*

COMMUNITY INTEREST PROJECTS*

By Arthur W. Schmidt
Lead High School, Lead, South Dakota

A project of this type consists of a careful study of phenomena or events that are of social or economic value to society in general. The topics for investigation as projects should bear a definite relationship to the unit of instruction being pursued in the class-room at the time the projects are performed outside of class in their natural settings. The first step in adopting this type of project is to secure the greatly desired enthusiasm of the students; the second is to have proper and accurate outline forms or skeleton maps on which the students can record their observations; and the third is to give careful instruction in the use of materials needed to carry on the investigation, and to make the assignments.

A unique example is afforded by the Community Interest Projects as carried out by students of natural science in the Washington High School of Sioux Falls, South Dakota. There the projects were pursued in connection with the unit of instruction entitled "Beneficial and Harmful Plants." Aside from the general aim of the unit of instruction as followed out in the regular class-room procedure, the chief problem or question of the project was to locate definitely each plant, to ascertain the abundance of each type of plant, and to report to the State Agricultural Office the location of all harmful plants found in the community.

To stimulate interest in introducing the projects the instructor secured the cooperation of the Division of Barberry Eradication, Bureau of Plant Industry, United States Department of Agriculture located at the State Agricultural College. Through the assistance of the state agent the classes were shown a two-reel film entitled "Rust," illustrating the relationship of common barberry bushes to black stem rust on wheat plants. The students were taken on a field trip where they were shown a barberry bush that had been previously discovered by a member of the class. They were shown examples of black and red stem rust on wheat plants, and attention was called to the effect that it produced in the quality of the grain. They

* The project described in this article was carried out under the direction of Mr. Elton H. Bissell, instructor in biology in the Washington High School, Sioux Falls, South Dakota.

were informed that each individual who discovers a barberry bush would be awarded a bronze medal by the Conference for the Prevention of Grain Rust, Minneapolis, Minnesota; a Certificate of Award signed by the governor of the state, enrolling him as a life member of the National Rust Busters' Club; and that the discovery of a barberry planting would also entitle him to credit for a project.

Through the cooperation of the Department of Biology of the State Agricultural College with the Division of Barberry Eradication each student interested was provided with a simplified key to the more common trees and shrubs likely to be discovered. Other materials used consisted of survey sheets, note pad, and pencil. On each survey sheet were printed lists of the trees, shrubs and hedges to be found in the state, and an outline map of a city block.

The students who elected to carry out a project of this type were then taken on a preliminary class field trip where they were carefully instructed in the use of the key to identification and in the manner of proceeding with the survey. They were required to plot on the outline map the location and name of each tree and shrub growing in the assigned area. In their note pads they were to record carefully all the common characteristics and peculiarities of each plant. The students were permitted to work in pairs or singly, and indicated on a large city map posted on the bulletin board the area they chose to survey. Upon completion of the survey they compiled their results in the form of a report setting forth the identifying characteristics, the beneficial or harmful nature, and any other information regarding each plant that the instructor may have requested.

The amount of credit granted for the work depended upon the density of plant growth on a given area, and upon the number of plantings of any distinctly harmful plant discovered. Nearly three hundred barberry bushes were found during two semesters either directly or indirectly as a result of the Community Interest Projects carried out by the natural science students of this high school. Seven different persons were given medals and awards.

To assure the residents of the town that there was no ulterior motive in the plan of survey followed by the students in their individual work, each student was provided with a card of identification bearing the approval of the high school prin-

cipal and the sanction of the city mayor. While actively engaged in the survey each student was required to wear a "Rust Buster" badge, supplied by the Division of Barberry Eradication. To inform the residents of the town of this instructional activity news articles were published in the local papers stating that the young people would pay them a visit and ask their cooperation by permitting them to examine the trees and shrubs on their premises.

SCIENCE IN A COMMUNITY ACTIVITY PROGRAM

By Winifred Perry
Roosevelt Junior High School, San Diego, California

Science teachers in the Junior High Schools, in particular, have a splendid means of motivating their subject through an interest in the Boy Scout, Girl Scout and Camp Fire programs. Each of these organizations fosters an activity program which ties in very effectively with the established General Science curriculum.

The average boy and girl is delighted to kill two birds with one stone. If the pupil can use his science work toward a merit badge, if a boy scout; toward an observer's badge, Rambler's badge or a Naturalist's badge, if a girl scout; or towards one of the Big Honors if a camp fire girl, the work of the classroom has a challenge that is extraordinary.

The writer is not suggesting that science teachers in general should become scout masters or leaders of girl scout or camp fire groups. The teacher load is usually too heavy to permit them to assume this added responsibility, pleasurable as it may be. However, every science teacher should familiarize himself with the portions of the manuals of these organizations which are so closely related to his subject. [1, 2, 3] Then as each new unit of work is introduced he may suggest that the pupils who do this work thoroughly, may easily pass the various tests which are outlined in the manuals. After a few weeks of weather science or meteorology, the test on Weather Lore is easily finished by a camp fire girl, or a boy scout easily passes the one entitled Weather, and another honor is won. For the boy scouts

---

[1] Handbook for Boy Scouts of America.
[2] Scouting for Girls.
[3] The Book of the Camp Fire Girls.

the teacher may serve as "expert examiner" in many instances, and he may be of great assistance in the girls' work also.

A study of the three manuals referred to, shows the following subjects of a scientific nature which are the basis for tests leading to honors and a higher rank:

Boy Scouts	*Girl Scouts*	*Camp Fire Girls*
Agriculture	Bird Finder	Astronomy
Animal Industry	Canner	Bird Lore
Astronomy	Electrician	Fire Lore
Automobiling	First Aid	First Aid
Aviation	Garden Flower Finder	Gardening
Bee Keeping	Health Guardian	Insects
Bird Study	Health Winner	Minerals
Botany	Insect Finder	Personal Hygiene
Chemistry	Land Animal Finder	Plants, Trees and Flowers
Conservation	Motorist	Seashore
Electricity	Photographer	Weather Lore
First Aid	Rock Finder	Wild Animals
Forestry	Star Finder	Photography
Fruit Culture	Telegrapher	Poultry Keeping
Gardening	Tree Finder	Public Health
Insect Life	Wild Flower Finder	
Machinery		
Mining		
Personal Health		
Radio		
Reptile Study		
Safety		
Soil Management		
Taxidermy		
Textiles		
Weather		

A teacher seeking material for an activity program will find valuable material in each of the references cited. The requirements for the various honors include many projects of the identification and collection type which give an added purpose to the work of the classroom.

If the teacher will attempt to correlate the work of the classroom with that of these three organizations, Boy Scouts, Girl Scouts and Campfire Girls, he will find that he has not only increased interest in his subject, but has increased the mutual goodwill which is so necessary to a real learning situation.

Nothing can be loved and hated unless first we have knowledge of it.—LEONARDO DA VINCI.

VERBATIM REPORT OF A RECITATION IN ARITHMETIC AND GEOMETRY

By Joseph A. Nyberg
Hyde Park High School, Chicago

This is the fourth of a series of stenographic reports of what actually took place in a class. The following report was taken on Monday of the fifth week of school. Although not a junior high school the work was departmentalized in part, and this class consisted of a combined class in 6A and 7B pupils, 24 of each.

* * *

T. Ready for the division problem. (After adjusting some of the window shades the teacher continued.) 61 thousand 7 hundred 35 divided by 68.

After 3 minutes the pupils began to finish. Each pupil, as soon as he had finished, walked to the rear of the room, along the back to the aisle by the windows, and then to the front, handing their work to the teacher.

After 4 minutes the teacher said: A little bit faster.

After 6 minutes, T: All pupils bring your papers up whether finished or not. 16 pupils, who were still working, stopped. A minute later one boy was about to bring his paper forward but the teacher said: Too late now.

T. On Wednesday we will have our test for the quarter. The 7B will have review of fractions, decimals, estimate work, construction work. The 6A will have percentage, discount problems, and also review of fractions and decimals. If you have kept your note books up to date, you can tell by looking through them, exactly what you may be called on. I suppose Miss . . . has told you about the new kinds of marks on your report cards. F will no longer mean Fair, but Failure.

(10 minutes)

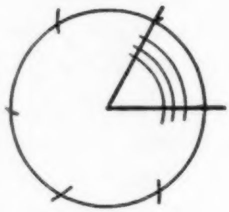
T. The 6A class! Work the problems on the board. 7B class, ready!

The teacher drew a circle on the front board. T. In making a circle, what do we call this outer line? (The teacher called on a pupil.)

P. Circumference.

T. Yes. That means the distance around. At *A* I want an angle of 60°. (The teacher drew the figure shown here.) What

do we call that curved line? (Drawing several arcs with the same center.)



P. An arc.

T. Would it make any difference if I put the arc here, or there, or there? (Pointing to the arcs between the sides of the angle). How many degrees in that arc?

P. Sixty degrees.

The teacher now drew another circle. T. What is an equilateral triangle?

P. All sides are equal.

T. Can't you give that in a sentence?

P. An equilateral angle is a triangle with all sides equal.

T. You mean equilateral *triangle*. Look at the difference between angle and triangle. An angle has two sides; a triangle has three sides. (Making a sketch of each as she talked.) Come to the board and make an equilateral triangle.

The pupil came to the board and began working; he was silent, and the teacher said: What are you making? Tell us what you are doing as you go along.

The pupil did not draw arcs intersecting the circle, but made merely a large dot at the intersections, marking 6 dots along the circle. He also called the center of the circle a dot.

P. Take the distance from the dot . . .

T. What do we call that distance?

P. Radius. Then I marked it off 6 times. (Pause)

T. What next?

P. I drew a line to every other dot. (The pupil drew 3 lines joining the alternate dots.)

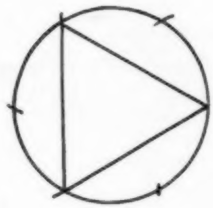
A pupil asked: Does it make any difference if you start the first dot at the top of the circle?

T. No. You would still get an equilateral triangle. How can you make a six pointed star in this way?

Several pupils raised their hands and seemed anxious to recite, but the teacher said: We will talk about that some other time.

T. How many degrees in this angle? (Pointing to one of the angles of the equilateral triangle.)

P. 60.



T. Any one happen to know what all these lines in the circle are called?

One pupil answered: Chords. The teacher wrote the word on the board. The figure was not lettered. T. Now look at this arc. (Drawing the chalk over one of the 3 equal arcs) What part of the whole circumference is this arc?

P. One third.

T. How many degrees all around that circumference?

P. 60.

T. I don't think you heard my question.

P. 160.

T. No. Don't you remember that story about the Babylonians, and how they counted 360 days in the year.

P. 360.

T. Then how many degrees in this arc?

P. 120.

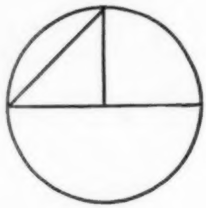
T. Yes. There are 60 in this angle, and 120 in this arc. Compare that to when the angle is at the center. How many degrees in this angle (pointing to the inscribed angle) and in this arc (pointing to its arc)? Now, when an angle is at the center, how does the number of degrees in the arc compare with the number of degrees in the angle? And when an angle is on the circumference, how does the number of degrees in the arc compare with the number of degrees in the angle? (Evidently answers were not expected at this time; six or eight pupils raised their hands ready to answer the questions.)

The teacher now repeated all the questions, and each was answered correctly.

T. In an equilateral triangle all the sides are equal, and all the angles are equal.

The teacher then drew a right angle at the center of a circle, and also an angle of 45° as in this figure.

T. How many degrees in this angle? (Pointing to the right angle.)



P. 90.

T. And in this arc? P. 90.

T. How many in this angle? (Pointing to the inscribed angle.) P. 45.

T. Yes. The measuring arc, as we call it, has twice as many degrees in it as the angle when the angle is on the circumference.

A pupil at his seat said: It's easy to see that that arc (pointing towards the front board) is 120 because you spread the radius out twice to find the points.

T. If we had a 45° angle on the circumference, how many degrees in the arc? P. 90. T. How many degrees around the entire circumference? P. 360.

T. If there were the same number of degrees in the arc as in the angle, this arc would be 45/360 or 1/8 of the circumference, and we can see it isn't.

P. It proves now that if the angle is on the circumference, it's half as big as the arc.

T. To-morrow we will take up parallel lines. How could we make lines parallel? We'll also learn what we mean by lines being perpendicular.

One pupil volunteered the information that one of the lines was "up and down."

(29 minutes)

The work with the 6 A class then began. The 7 B class evidently had some other work to do, but the teacher did not state what it was. The problems on the board which the 6 A class had been working were:

1. A piano listed at $400 was sold at a discount of 20%. Find the selling price.

2. A table marked \$50 was sold at a discount of \$8. Find the rate of discount.

3. A chair listed at \$15 was sold for \$12. What was the rate of discount?

The teacher walked around the room observing the work for 3 minutes, and then the recitation began.

T. If an article is marked \$10, and the discount is \$2, how much will you really pay? P. \$8.

T. An article was marked for \$15, and I got it for \$12. What was the discount? P. \$3.

T. A table marked \$24 was sold at a discount of \$2. How will I find the rate of discount? Rate means percent. The teacher wrote 2/25 on the board and continued: A business man would not say "I gave a discount of 2/25." A laundry advertises a discount of 20%. It does not say a discount of 1/5. How would you change 2/25 to percent?

P. Divide 25 into 200.

T. How did you get 200? P. Write 2, demical point, nought, nought.

T. Does the two zeros change the value of the 2? On one paper I saw this (writing on the board: .6⅔%) and on another I saw .06⅔%. You should not have both the decimal point and the % sign. The % sign takes the place of the decimal point. Sometimes, of course, you can have both the demical point and the percent sign. (The teacher wrote on the board: .8% = .8 of 1% or 4/5 of 1% and read it.) But that's a very small per cent. It is even less than 1%, and we won't have it in our problems. Carry out the division to two decimals; then if you drop the decimal point, you have the percent.

T. The list price of an article was \$35, and the discount \$4. Now when I ask for the rate of discount I mean "what percent 4 is of 35." Let us use the word ratio. What is the ratio of 2 to 8? P. Two eighths.

T. What is the ratio of 8 to 2? P. Four.

T. What is the ratio of 11 to 7? P. One and four sevenths.

The teacher divided 11 by 7 on the board, writing the quotient as 1.57 1/7 and then asked: What percent is that? No pupil offered an answer.

T. How many percent in that 1? P. 100.

T. How many percent in 1.57? P. 157%

A pupil asked: Can there be more than 100%? T. Oh, yes!

Eight divided by 2 equals 4. Four equals how many percent? P. 400.

T. For to-morrow write in percentages the ratio 5 to 8; of 7 to 2; of 8 to 12; of 25 to 6; of 4 to 15. (These numbers were read slowly so that the pupils could make a record of them.)

T. The list price was $25; the discount $6. What is the ratio of the discount to the list price? P. 6 to 25.

T. How can I change that to percent? P. Find six twenty fifths to two decimals. Two places gives percents.

(40 minutes)

T. Before we can find the rate of discount, you must find what? P. The discount?

T. (Pointing to the third problem on the board) If the chair was listed as $15 and sold for $12 what was the discount? P. $3.

T. What was the ratio of the discount to the list price? P. 3 to 15.

A pupil asked: Why can't you use 12 instead of 15?

T. Because 15 is the list price, and the ratio is taken to the list price. That gives a smaller percent. In figuring profits the ratio is taken so that the percent will be as small as possible; otherwise people would think the dealer was making an awful lot of money.

T. If you know the list price and the selling price, how would you find the discount? P. Subtract the selling price from the list price, and the answer that you get is the discount.

T. If you know the list price and the discount, how do you find the rate of discount? P. Take the ratio of the discount to the list price and change it to percent.

T. If you know the discount and the list price, how do you find the rate of discount?

Four pupils were called to answer this question and could not. No one volunteered an answer.

T. Now listen. First I asked: If you know the list price and the discount, and then I asked: If you know the discount and the list price? Aren't they the same things?

T. Take out your note books. (Pause) Write as I dictate: To find the discount, subtract the selling price from the list price. That's the first point. The second point is: To find the rate of discount, take the ratio of the discount to the list price.

T. A coat cost \$50 and was sold at a discount of 8%. What do we call the 8%? P. The rate.

T. Now write this: To find the discount when the list price and the rate are given, multiply the list price by the rate of discount. Underneath that you better write: 8% of \$50.

T. For the lesson after our test we are going to have "interest" and "banking". You might get some blank checks from a bank. The policeman at the bank on . . . street is very kind about giving blank forms to the children if you tell him what you want them for at school.

(50 minutes)

The class in pedagogy may now discuss these questions:

1. Was the word circumference used correctly? What does the National Committee Report say about the words circle and circumference?

2. Should the intuitive geometry of the seventh grade include any work showing that an inscribed angle equals half its arc? The teacher, when questioned, said it should not but that the topic had developed from some questions by a pupil on a previous day. Was the teacher right or wrong in spending this time on the topic? Will this discussion help to make the geometry of the tenth grade easier when the pupils get there?

3. What irrelevant fact about an equilateral triangle was mentioned several times?

4. Should the teacher have lettered the figure instead of talking about this arc and that arc?

5. Imagine you are preparing an outline of the topics from geometry that can be profitably treated in the seventh grade? What topic would precede and what topic would follow the work on parallel lines?

6. What advantage is gained by having the teacher tell what topic will be studied next?

7. Criticize the teacher's statement that "rate means percent."

8. Why were the problems in arithmetic written on the blackboard instead of being assigned from the textbook?

9. Why did the teacher dictate the rules instead of having the pupil read the rules given in the textbook?

10. Assume that a pupil has been absent from the class when the class learned how to change a fraction to percents. He asks in class how it is done. Would you explain the method

again, would you call on some pupil to explain it, would you keep the pupil after school to teach him, or what would you do?

11. According to the teacher's rule for changing a fraction into percent, isn't $\frac{1}{8} = 12\%$?

12. If a pupil wrote $.6\frac{2}{3}\%$ as an answer, what should the teacher say to correct the error? Just what is it about percents that this pupil has not learned? Did the teacher's explanation help?

13. How would you answer the pupil's question about 12 being used instead of 15 to find the rate of discount?

ALCOHOLIZED GASOLINE

Alcoholized gasoline has been given a test under a wide range of motoring conditions in several sections of the country, most notably in the Midwest, where the states of Illinois and Iowa, as well as several private concerns, have made alcohol-blended gasoline available to several sample communities. Advocates of the pending legislation declare that the experience of many hundreds of motorists who have reported on their tests constitutes an almost unanimous endorsement of the alcoholized fuel.

A summary of reports of 1,327 customers, who gave their impressions of alcoholized gasoline on the scores of starting, acceleration, smoothness of operation, anti-knock, power and general motor performance, shows that over 1,100 of them considered the new fuel better than "straight" non-premium gasoline on starting, and that on all the other points over 1,200 agreed that the new fuel was superior. Most of the dissenting votes merely reported "no difference noticed"; hardly anyone considered the unblended gasoline to be better.

One driver in Peoria, Illinois, who repeated a 128-mile road trip, using 10 per cent alcohol gas, regular gas, and ethyl gas, found that with alcohol gas his fuel cost was 1.48 cents a mile; with regular gas 1.53 cents a mile and with ethyl gas 1.60 cents a mile; and this in spite of the fact that he was paying 18.6 cents a gallon for the alcohol gas, as against 14.6 cents and 18 cents respectively for the other fuels.

The tests were conducted for the most part on gasoline containing an added ten per cent of alcohol, which is double the highest percentage contemplated in the bill now before Congress. However, the provisions of this measure are such that the oil producer is not required to use alcohol in all his gasoline. He may, if he likes, add a high percentage to his lowest-grade gasoline, thereby raising its quality and hence also its price, while continuing to sell his "straight" and "premium" gasolines unmixed. This, advocates of the bill claim, will do much toward solving the problem of the cheapest grades of gasoline, which at present are not very profitable for the producer nor particularly satisfactory to the consumer.—*Science Service.*

Joint Meeting of
EASTERN ASSOCIATION OF PHYSICS TEACHERS
124th Meeting—Annual Meeting
and
NEW ENGLAND ASSOCIATION OF CHEMISTRY TEACHERS
145th Meeting

Thompson Science Building
The Phillips Exeter Academy, Exeter, N. H.
Saturday, April 8, 1933

PROGRAM

MORNING SESSION

9:45 Meeting of Executive Committee of the E.A.P.T.
10:15 Business Meetings—held separately.
10:45 Address of Welcome by Principal Lewis Perry.
11:00 Reports of Committees of both Associations (Joint meeting)
11:45 Annual Address of the Vice-President of the E.A.P.T. Mr. Hollis D. Hatch, English High School, Boston.
12:15 Address "Pulp and Paper" by Dr. F. W. Adams, Massachusetts Institute of Technology.
1:00 Luncheon. Members of both Associations will be guests of the Academy.

AFTERNOON SESSION

2:00 Address "Experiments with Liquid Air." Dr. Harold A. Iddles, University of New Hampshire, assisted by Dr. James A. Funkhouser and Mr. Alfred H. Taylor.
3:00 Inspection of the new Thompson Science Building.
4:00 Tea at Phillips Hall.

NOTES

At the E.A.P.T. business meeting the election of officers for the coming year will be held.

On Saturday, April 15, at 3 P.M., the four latest talking picture releases on Visual Education edited by the University of Chicago Press, will be shown at the Lewis J. Warner Memorial at Worcester Academy. Worcester Academy cordially invites all members of the N.E.A.C.T. and E.A.P.T. to be present at this program. It includes a picture on: 1. "Oxidation and Reduction"; 2. "Molecular Theory of Matter"; 3. "Electrostatics"; 4. "Energy and Its Transformation."

Next meeting N.E.A.C.T. May 13 at New Haven, Conn.

All persons receiving this program are urged to extend an invitation to attend to anyone interested in the meeting.

If you are not a member and wish to join either or both of our Associations, application blanks may be obtained from the secretaries.

E.A.P.T.
LOUIS WENDELSTEIN, *President*
WILLIAM W. OBEAR, *Secretary*
High School, Somerville, Mass.

N.E.A.C.T.
NORRIS W. RAKESTRAW, *President*
OCTAVIA CHAPIN, *Secretary*
High School, Malden, Mass.

ANNUAL REPORT OF THE SECRETARY

Since the last annual meeting we have held four meetings as follows:

May 14, 1932, at the English High School, Lynn, Mass.
Dec. 3, 1932, at the Teachers College of the City of Boston.
Feb. 4, 1933, at Massachusetts Institute of Technology, Cambridge, Mass.
April 8, 1933, at Exeter, N.H., as guests of the Phillips Exeter Academy, Exeter, N.H.

We have for parts of these meetings joined with the New England Association of Colleges and Secondary Schools, the New England Section of the American Physical Society, and the New England Association of Chemistry Teachers.

The excellent attendance at every meeting testifies to the attractiveness of the programs which have been provided.

On March 11, 1933, a group of members and friends numbering about 70 visited the Charlestown Navy Yard and were given a very unusual opportunity to inspect the 10,000 ton cruiser Portland which had just been put in commission. All parts of the ship were open to us and the officers took great pains to give us all the information we asked for.

Including the election today our membership is now 178. There are 116 active members, 60 associate members and 2 honorary members. This is 8 less than at the last annual report. This shrinkage in membership is partly due to the retrenchments which teachers are finding it necessary to make and partly to a pruning of the membership list by the Treasurer.

A change in policy was initiated this year by a change in the by-laws which provides that the annual meeting be the last meeting of the school year thus making the year of each administration correspond with the school year.

Respectfully submitted,

W. W. OBEAR, *Secretary*

REPORT OF THE TREASURER, 1932-1933

Balance from 1931-1932		$309.87
Receipts:		
Dues, Active 1931-32	$ 19.50	
Active 1932-33	284.00	
Associate 1931-32	3.50	
Associate 1932-33	98.00	
Interest	7.07	412.07
		$721.94
Expenditures:		
Printing and Stationery	$ 37.20	
Postage	33.78	
Clerical work		
Secretary	1.00	
Treasurer	22.00	
Salary of Secretary	50.00	
Expense of meetings	10.25	
Tax on checks	.34	
	154.57	

School Science and Mathematics	257.50	412.07
Balance		$309.87

Assets

First National Bank of Boston, Savings department	$262.67
First National Bank of Boston, Commercial department	43.20
Cash	4.00
	$309.87

Respectfully submitted,

William F. Rice, *Treasurer*

April 8, 1933. Examined and found correct. Charles S. Lewis, *Auditor.*

Mr. Arthur L. Evans of the English High School, Boston, Mass., was elected an active member.

President Wendelstein expressed his thanks to the members of the Association for the support and co-operation which he had received during the year.

The nominating committee, Mr. Fred R. Miller, Chairman, Mr. Ambrose Warren, and Mr. Frederick Boyce, presented the following candidates and they were elected to serve for the ensuing year.

President: Louis A. Wendelstein, High School, Everett, Mass.
Vice-President: Hollis D. Hatch, English High School, Boston, Mass.
Secretary: William W. Obear, High School, Somerville, Mass.
Treasurer: William F. Rice, Jamaica Plain High School, Boston, Mass.

Executive Committee:

Joseph M. Arthur, St. Mark's School, Southboro, Mass.
Kenneth L. Goding, High School, Attleboro, Mass.
Preston W. Smith, Rivers School, Brookline, Mass.

It was voted to extend on the part of the two Associations our official thanks to the Phillips Exeter Academy and members of its Science Department for their splendid hospitality today.

REPORT OF THE COMMITTEE ON COLLEGE ENTRANCE REQUIREMENTS

Burton L. Cushing, *Chairman, East Boston High School*

The following report presented by the chairman aroused considerable discussion.

"Believing first, that the present syllabus contains too much material for a one year course in Physics and second, that recent developments require the addition of some new material, the E.A.P.T. recommends to the C.E.E.B. a complete revision of the syllabus. The association further urges that whatever topics are added, the net result shall be a considerable reduction in the total content of the syllabus.

"We suggest the following changes:

"(1) That the syllabus be divided into two parts: (a) minimum essentials which should be included in all courses and (b) optional topics from

which a choice could be made depending on the needs and equipment of different schools and localities.

"(2) That some of the newer Physics such as cathode rays, ionization, the photoelectric effect, and the principles of radio, and modern refrigeration be included in the optional topics.

"(3) That a considerable amount of the mathematics be included under the optional topics.

"(4) That the examination also be in two parts, (a) required questions on the minimum essentials and (b) a choice among questions to be based on either more difficult phases of the minimum essentials or the optional topics, there being a sufficiently wide range of choice so that a pupil who has had a good course in Physics should be sure to find enough questions he can answer to make up the total required number in the examination."

An informal show of hands indicated that the members of the Association believe that some changes in the College Entrance Examination Board requirements should be advocated. But as no agreement on details could be reached in the short time available for discussion it was voted to refer the report back to the committee to be further considered at the next meeting.

REPORT OF COMMITTEE ON MAGAZINE LITERATURE AND NEW BOOKS

C. W. Staples, *Chairman, Chelsea High School*

BOOKS

"Progressive Problems in Physics," new edition, by Fred R. Miller. Published by Heath and Company. Many of us look upon Mr. Miller's book as an old friend. It was used in Everett High when I studied Physics, and I have used it a great deal since in teaching the subject.

The new edition, however, is completely revised, and while it retains many of the old familiar problems, it has a wealth of new materials, both problems and diagrams, based on recent scientific discoveries, and on commercial applications of Physics.

Some few problems, which, in the older editions, admitted of more than one interpretation, have been restated in a manner which is admirably clear.

A new interest and vitality has been infused into the book, with here and there a touch of quiet humor (as in problems 210 and 212) which could not fail to appeal to the alert school boy or girl.

The book will probably be ready about the fifteenth of this month.

"Strength and Stability of Concrete Masonry Walls," by Richart, Moorman, and Woodworth, January 1933. Published as Bulletin No. 251, Engineering Experiment Station, University of Illinois.

"Temperature and Humidity Measurement and Control," by M. F. Béhar. Pittsburgh, Pa., Instruments Publishing Co. Handbook, $2.00. This is parts 2 and 3 of the "Manual of Instrumentation" that Mr. Béhar is preparing, and is a summary of temperature control and pyrometrical technique, and also a comprehensive discussion of humidity.

"Elektrizität unter Tage," by W. Philippi, Leipzig, Ger., S. Hirzel, Publisher. A general description of common types of motors, generators, transformers and converters, underground cables and transmission lines, hoisting and pumping machinery, drilling and cutting equipment, etc., used in modern mining.

"Navigation and Nautical Astronomy," by Benjamin Dutton. Annapolis, Md., U. S. Naval Institute. 1932. (Boston Library.)

"Institut für Meereskunde, Berlin." Polarbuch, Berlin, 1933, by various contributors. A series of articles, accounts of recent polar expeditions by the air-ship "Graf Zeppelin," sledge, submarine, and other vessels. (Copy in Boston Library.)

"Time, Matter, and Values," by Robert A. Millikan, Chapel Hill, 1932, 99 pages. A brief exposition of the most important changes in fundamental concepts which have resulted from modern scientific discoveries, discussed from the philosophical view-point. (Copy in Boston Library.)

"Where is Science Going?" by Max Planck. Norton, 1932, 221 pages.

"The originator of the quantum theory surveys the progress of Science in the past 50 years." (Copy in Boston Library.)

"The Principles of Electromagnetism," by E. B. Moullin; Clarendon, 1932.

MAGAZINE LITERATURE

Aeronautics

"Ballooning in the Stratosphere," (34 illustrations) by Auguste Piccard, *National Geographic Magazine*, March, 1933, p. 353.

"Gliders Taught by Falcons and Eagles," *Illustrated London News*, February 25, 1933.

"The R.A.F. 5340-mile Non-Stop Flight that Gained a World's Record," *Illustrated London News*, February 18, 1933, p. 230.

"The Truth About High Altitude Flight," by W. H. Evers, *Scientific American*, March, 1933, p. 154.

Astrophysics

"More About Meteors," by Henry Norris Russell, Ph.D., *Scientific American*, February, p. 78.

"The Limits of the Solar System," by Henry Norris Russell, *Scientific American*, March, p. 144.

"Distribution of Meteors in North America," *Popular Astronomy*, March, p. 171.

Six Articles on Spectroscopy, *Astrophysical Journal*, March, 1933.

Building Construction, Physics in relation to

"A Modern Tower of Babel" (Preparing models of Rockefeller Center), *Popular Mechanics*, March, p. 354.

Ceramics, Physics in relation to

"L'École Supérieure de Ceramique de Sevres," *L'Illustration*, February 25, 1933.

Crime-Detection

"The Ever Open Eye," Science in Crime Detection, *Popular Mechanics*, March, p. 410.

Electricity

"Lightning Protection of Distribution Transformers," *Electrical World*, March 4, p. 290.

Electroplating

"Electroplating with Zinc-Cadmium," A new simple process for coating iron with a durable rust-proof alloy. *Popular Science*, April, 1933, p. 82.

"New Process of Electrolysis which Produces Rare Metals in Pure State," *Metal Industry*, February, 1933, p. 63.

Energy

"Our Supply of Energy," by Arthur B. Lamb, *Technology Review,* March, 1933, p. 215.

Geophysics

"Tremendous Tasks that Confront the Climbers of Everest," *Illustrated London News,* February 25, 1933, p. 267.

Heat

"Air-Conditioning a Civic Auditorium," by Burritt A. Parks, *Heating and Ventilation,* March, 1933, p. 12.

"The Sun's Heat," by Edward Godfrey, *Popular Astronomy,* March, 1933, p. 139.

Historical

"Une Visite au Laboratoire d'Edouard Branley," *Le Monde Illustré,* February, 1933, p. 84.

"Friedrich Koenig, der Erfinder der Schnellpresse," Zu seimem 100 jahrigen Todestag (January 11), *Illustrierte Zeitung,* January 12, 1933, p. 50.

Hydraulics

"Water Conservation the Key to National Development," by Calvin V. Davis, *Scientific American,* February, p. 92.

"Hydraulic Equipment for the Hoover Power Plant" (Plans, etc. given), *Power Plant Engineering,* March, 1933.

Light

"Underneath the Artist's Paint" (Scientific study of paintings), *Scientific American,* February, 1933, p. 84.

Illustrierte Zeitung for December, 1932. Almost the entire number consists of a history of light and lighting. It is an excellent account and especially well illustrated.

"Beam of Light Carries Music," *Popular Science,* April, 1933, p. 37.

"Glow-Lamps for Home-Lighting," by Alden P. Armagnac, *Popular Science,* April, 1933, p. 41.

"How to Take Pictures with your Microscope," *Popular Science,* April, p. 48.

Metals and Alloys

"Some Economic Aspects of Welding Aluminum," by D. E. Roberts, *Metal Industry,* February, 1933, p. 61.

"X-Ray Analysis of Electrodeposited Alloys," by Charles W. Stillwell, *Metal Industry,* February, 1933, p. 47.

"La Radiometallographie," *Revue de Deux Mondes,* February 15, 1933, p. 936.

"Adding Chromium to Cast Iron and Its Effects," by F. W. Meyer, *The Iron Age,* March 9, 1933, p. 393.

Mining

"Mining from the Air," by J. J. Rowlands, *Technology Review,* March, 1933, p. 211.

Power

"New Sources and Uses of Power," *Popular Mechanics,* March, 1933, p. 376.

Safety in Driving, Physics applied to

"Daredevil Tells Secrets of Safety," *Popular Mechanics,* March, 1933, p. 346.

Sound

"An Entertainment Treasure-House," by Albert A. Hopkins (Largest theater in world Rockefeller Center) (Illustrated), *Scientific American,* March, 1933, p. 152.

"Talkie in Several Languages Made with Discs," *Popular Mechanics,* March, 1933, p. 429.

Specific Gravity

"Heavy Water" (due to isotope of hydrogen), *Science,* March 10, 1933, Supplement, p. 8.

Telephony

"The Telephone Goes to Sea," by C. W. Tucker, *Scientific American,* February, 1933, p. 98.

Television

"Television in England. Brief Survey of Events of 1932 Indicative of General Trend," *Scientific American,* February, 1933, p. 76.

Testing and Standards

"Informative Curves from Prosaic Figures," by Dean Harvey (Statistical method of analysing a body of data and its application to commercial testing), *Electric Journal,* March, 1933, p. 110.

"Testing Devices. How Fast Can You Think?" (Physics applied to psychological tests), *Popular Mechanics,* March, 1933, p. 386.

"Revision of International Electrical Units," *Science,* March 10, 1933, p. 251.

Transportation

"Deutschlands Schnellster Zug," *Illustrierte Zeitung,* January 12, 1933, p. 53.

"Speedier Engines Being Built for British Railroads," *Popular Mechanics,* March, 1933, p. 361.

"The Submarine Crews' New Escape-Lock and 'Parachute'," *Illustrated London News,* January 21, 1933, p. 89.

"Courage" (Salvaging the S-51) by Commander Edward Ellsberg, *Popular Mechanics,* March, 1933, p. 394.

"Baby Submarine on Wheels to Seek Treasure," *Popular Mechanics,* March, 1933, p. 341.

REPORT OF COMMITTEE ON CURRENT EVENTS

J. P. BRENNAN, *Chairman, Somerville High School*

Dr. Derrick N. Lehmer, professor of mathematics at the University of California and his son Derrick H. Lehmer have built "a congruence machine, a device for determining the prime factors of large numbers. With light rays, photo-electric cells and an amplifier that magnifies the light impulses over 700,000,000 times they are able to find the prime factors of such numbers as 1,537,228,672,093,301,419 in very short order. Such numbers as 39,614,081,257,132,168,796,771,975,169 take a little longer time. The instrument is to be used in the study of the theory of numbers.

Using a catalyst, the nature of which has not yet been revealed, engineers of the Eastman Kodak Co. have developed a new scheme for recovering waste silver from the photographic baths of the film industry. The new process, which is electrolytic in character, employs cells having a capacity

of 10,000 gallons of fixing bath. In six months of operation, about two tons of silver, having an approximate value of 17,000 dollars, were recovered.

Some new data, gathered by assistants of Dr. Robert A. Millikan at Panama, indicates that the intensity of cosmic rays coming to the earth increases as the observer approaches the magnetic pole. These results seem to confirm the earlier reports of Dr. Arthur H. Compton of Chicago. It would seem that the opinions of these distinguished authorities on cosmic rays, hitherto at variance are leading in the same direction and may eventually merge.

The airplane to be used by the British expedition in its attempt to conquer Mt. Everest, attained an altitude of 35,000 ft. with full load during a recent trial trip held in England. At that height, the temperature was 76 degrees below zero. Ice formed on many of the instruments, but the pilot and observers were kept warm by electrically heated suits.

Open house will be held at Massachusetts Institute of Technology on May 6. Many interesting exhibits have been prepared and the various professional societies are working hard to present a fine program of events for the day.

The Germans are not the only ones who are developing high speed railway cars. The Michigan Central lines have brought out a streamlined coach, a kind of cross between an automobile and a railroad car, that travels from 70 to 90 miles an hour. Aluminum is being used to reduce weight and vibration is brought down to the minimum by the extensive use of rubber. It is claimed that the new coach can be operated at a cost of 10½ cents a mile. This figure does not include labor but it does include fuel, maintenance and depreciation.

Experiments by Sir Leonard Hill, the English authority on respiration, indicate that one of the causes of discomfort in "stuffy" rooms is the emanation from dark bodies, such as steam radiators, and glowing coals of long heat rays. These rays cause the muscles of the nostrils to contract and by stopping up the nasal passages make breathing difficult. There are other rays that are given off by bright exposed flames which have the opposite effect of opening the nostrils. Moisture seems to absorb the non-shutting rays, hence the beneficial effect of a pan of water on the radiator. As a result of careful experiments Sir Leonard found that 60% of those exposed to the long rays experienced difficulty in breathing normally.

An exploring expedition including such famous names as Ellsworth Lincoln, Sir Hubert Wilkins, Bernt Balchen and others will attempt to fly across Antarctica next December. This expedition will try to establish radio communication during the flight with another expedition under the Norwegian Riiser-Larsen who is planning to explore the region known as Coates Land in the vicinity of the Weddell Sea.

A new stroboscope has been developed at the Massachusetts Institute of Technology. With this instrument thousands of pictures a second can be taken. An automobile piston traveling at high speed can be made to appear to naked eye as if it were standing still. This instrument will greatly facilitate the study of the behavior of metals and other materials while in operation in high speed machinery.

The photo-electric cell is being adapted to the engraving business. The photograph or picture from which the engraving is to be made is mounted on a cylinder which revolves in step with another cylinder on which is mounted the zinc plate to be engraved. As the picture revolves the cell is actuated by the light reflected from the picture and so controls the tool which cuts the engraving.

ADDRESS OF WELCOME

Principal Lewis Perry extended a hearty welcome to the members of the visiting Associations. Changes in Science and its teaching, he said, are of great significance to the world. Phillips Exeter has open ears to the call which Science is making to youth. He spoke briefly of the career of the donor of this Thompson Science Building. He expressed his belief that science teaching is now in "its great beginning."

REPORT OF COMMITTEE ON NEW APPARATUS

MR. JOHN C. PACKARD, *Chairman, Brookline High School*

Mr. Hatch, the vice-president, in connection with the annual address showed a simple form of Linear Expansion Apparatus—easily made in the laboratory and capable of giving excellent results.

Mr. Rice showed a simple illustration of the elasticity of glass.

Mr. Perry showed a photo electric cell with amplifier for use with alternating current.

Mr. Stanley, of the Chicago Apparatus Company, displayed (a) a String Vibrator developed to provide a simple dependable means for the production of standing or stationary waves in strings. The apparatus was operated on an alternating current. (b) A spectacular Critical Angle Apparatus consisting of a tiny electric light placed in the bottom of a round cylindrical tank opaque at the sides. Upon filling the tank to the brim with water the light suddenly appears at the upper surface of the water as one peers across the top of the dish. Quite convincing. (c) A Dry Plate Rectifier. Provides a dependable source of rectified current (6 volts, 2 amperes) from any 110 volt A.C. outlet. To be used for charging a storage battery, in connection with experiments in electrolysis, electroplating, etc. Neat and effective.

Mr. Packard displayed a beautiful set of Optical Charts, published and distributed free of charge by the Better Vision Institute, 205 East 42nd St., New York.

ADDRESS OF THE VICE-PRESIDENT

HOLLIS D. HATCH, *English High School, Boston*

This morning I shall talk of several ideas in teaching Physics original with myself. None of them are very astonishing and those who wish I had collected the wisdom of others for you will, I hope, be patient.

I. One of the troubles I encounter throughout the year is square root. The method which can be developed from the binomial theorem is satisfactory and I tell the boys who remember it to use it. I use it myself when I do not use a slide rule, logarithms or the following method I have devised.

The idea of a square root is a number which, multiplied by itself, gives the number you start with. My method is to find a number which, divided into the given number, will give itself. The idea is a consequence of the idea of square root which I find my boys see at once. Only as I shall point out it is not necessary to actually divide more than twice and often only once.

Suppose we wish to find the square root of 699.4. Pointing off in pairs from the decimal point 699.40 shows that the answer contains two digits to the left of the decimal point and inspection of the six shows the answer is twenty something. I tell a boy to make a guess of a twenty as a starter. A bright boy will make a close guess; suppose a not real bright one says 23. I divide 699.4 by 23 by ordinary division and get 30.4. We now see 23 was too small but 30.4 is too large. So I take the average of them—26.7—and divide again. The quotient is 26.2 and the average 26.45. The real root is 26.44. This is quite accurate enough for any work in Physics and with an ordinary boy much easier to teach him than any other way I know.

How accurate is the method? How near must the divisor and quotient be that their average is practically the square root? Suppose we divide "a" by "y" and get "x" and x and y are ten per cent of y different. Then

$$x = .9y$$

The average is $\frac{x+y}{2}$ and the $\sqrt{a} = \sqrt{xy}$

The difference in the average and the root is

$$\frac{x+y}{2} - \sqrt{xy} \text{ which equals } \frac{.9y+y}{2} - \sqrt{.9y^2}$$

This simplifies to: $.95y - .9487y = .0013y$

This shows that when the factors are within ten per cent of each other their average is within 1/7 of one per cent of the root. Therefore you need not continue until you get exact agreement but only until they are ten per cent or less different.

I have made one assumption in the above which needs proving to a group of teachers; namely, that the average $\frac{x+y}{2}$ is always greater than the root. Assuming the same factors i.e. $a = xy$ let the average of the factors be s. Then

$$\frac{x+y}{2} = s \text{ and: } x + y = 2s \text{ then } \frac{a}{y} + y = 2s$$

Differentiate in respect to y and we get:

$$\frac{-a}{y^2} + 1 = 2\frac{ds}{dy}$$

From this we find that the minimum "s" is when $\frac{-a}{y^2} + 1 = 0$

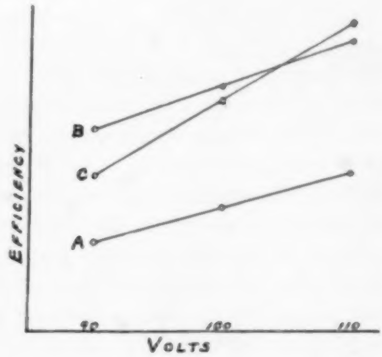
$$\text{or } y^2 = a \text{ or } y = \sqrt{a}$$

Any average, not exactly right, is therefor somewhat too large. This fact is sometimes handy for the teacher to remember but I doubt if you should use it in class.

II. Here is a new coefficient of expansion apparatus which is the result of dozens of somewhat similar forms. Some were too hard to make, others too fragile, and some worked nicely for me but not for the boys. It consists of a ¼ inch tube that reaches from the floor to above the table top; a 4″ by 5″ base board with a hook, two slotted guides and a hole in it; a pointer; a clamp; and the movable knife edge. In use clamp the wood to the table with the hole over the edge, place the tube whose expansion is to be measured through the hole and resting on the floor; add the knife edge over the tube and through the guides. Steam enters at the top when wanted, expands the tube which raises pointer resting on the knife edge. Measurements of temperature, multiplying power, and pointer readings are made as with the old type. In fact direction sheets for the old style will need little change for this new one.

There are numerous advantages: First it is inexpensive. Then no stoppers are used to block the steam path. It is not complicated or delicate. The tubes, pointers, baseboards, and knife edges are interchangeable. And when you are done with it it comes to pieces and packs away in very little space. The pointer rise is greater than in the old type for two reasons: the expansion tube is about 90cm long instead of 60cm and the pointer is a third class lever instead of a first. It will work with any quarter inch tube including glass. It will be placed on the market this fall by one of two apparatus companies: a teacher who would like to examine it may write to me and have their request forwarded.

III. Recently there appeared on the market a series of ten cent electric light bulbs made by a large American manufacturer to compete with those imported from Japan. I was curious to compare their efficiencies; so at a local chain store I purchased a 10c Japan bulb (A), a 10c American one (B), and a 20c Mazda (C). All were of the same size. I measured their efficiencies at 90, 100, and 110 volts. The results are given in the accompanying graph.



The efficiency was gotten by dividing the output (light) by the input (watts). The watts were obtained by a good voltmeter and ammeter; the light emitted I measured two ways. First I used the Bunsen Photometer as I imagine many of you have. Then I tried the new Weston Photronic Exposure-meter. This latter contains a photoelectric cell and a microammeter and is calibrated to give the exposure for camera work. It proved very quick and simple to use to compare the light from different sources as wanted here. The results were practically the same by both methods.

The curves show several things: The Japanese bulb is nowhere near as efficient as either American bulb. Between the two domestic ones I asked myself which one was better. As far as light efficiency at 110 volts goes there is little difference. The fact that the 10c one is more efficient at lower voltages indicates that it must be then at a higher temperature. This, I decided, must be due to the use of a thinner, shorter wire and is a reason why the bulb can be sold at a lower price. I have written to the manufacturers of this bulb and they tell me that the above is correct. The 10c lamp was developed to meet price competition. It will not last as long as the 20c one but is better in every way than the imported one. I believe it is a good example of the way American concerns can and should meet foreign competition.

THE PULP AND PAPER INDUSTRY

Dr. F. W. Adams, *Massachusetts Institute of Technology*

Pulp and paper form the basis of one of the largest industries of New England and New Hampshire, an industry whose processes are dependent on chemical reactions and physical phenomena, many of which fall in the border zone between physics and chemistry.

Papermaking is an art dating into antiquity in its utilization of natural fibers for producing a sheet of paper suitable for writing or printing. The fibrous raw material such as ramie, various grasses and later old rags was beaten to a pulp with water by mortar and pestle. The beating process caused the hydration and fibrillation of the cellulosic materials, covering the fibers with a gelatinous layer which on subsequent drying cemented them together into a strong sheet of paper. A thin suspension of the beaten pulp stock was made with water and the sheet of wet paper was formed by dipping the mold into a vat of this suspension and allowing the water to drain through the wires or screen forming the bottom of the mold. A frame setting on top of the mold retained sufficient suspension to make a sheet of suitable thickness and formed the edge of the sheet. When drainage of the water was complete the frame was removed and more water was abstracted by pressing the wet sheet between absorbent sheets of blotting paper or felt. The wet sheet was removed on a piece of felt and then hung up in the air to dry.

Beating was a laborious hand process of low capacity and the forming of the sheet was a heavy, wet job. In the eighteenth century mechanical developments in the form of the stamp mill and Hollander beater replaced the hand beating with machines of high capacity. The Fourdrinier machine for making a continuous web of paper was subsequently invented and perfected early in the nineteenth century. Both the Hollander beater and Fourdrinier machine are in wide use today and together account for the enormous increase in paper production during the last century. With

the impetus gained by the industry due to the development of these machines, the demand for paper making materials was greatly increased and about 1850 the domestic and foreign supply of rags was becoming inadequate. The chemists started work on the problem of supplying a new fibrous raw material and several years later the soda process was developed for producing white pulp from wood. This success was followed by the sulfite and sulfate processes.

Wood is composed of two classes of material, the cellulose fibers and the lignin bonding material. All of the chemical processes for producing pulp remove the lignin materials by decomposition and solution leaving a residue of cellulose fibers. About half of the weight of the wood is thus lost or destroyed. A mechanical process for producing woodpulp was also devised, in which the fibers are torn apart by pressing a log of wood against a large grindstone, keeping the wood continuously wet with water to prevent overheating. This mechanical pulp or groundwood pulp is obtained without appreciable loss of the wood. It is a cheaper pulp of low strength, but is well adapted for combining in large quantities with sulfite pulp to produce newsprint.

In all of the chemical processes the preparation of the wood is similar, involving the removal of the bark and dirt held by knots or pitch seams after which the log is cut into chips by a heavy revolving disc on the surface of which are mounted large knives. Spruce is the most widely used wood, although hemlock, fir, poplar and other woods are used to some extent.

The chips are put into large pressure vessels called digesters holding around twenty cords of wood and are cooked to remove the lignin. In the sulfite process, a solution containing calcium and magnesium bisulfites and an excess of sulfur dioxide is used for cooking. It is prepared by burning sulfur to form sulfur dioxide and absorbing the gas in milk of lime. Sulfite acid is exceedingly corrosive so that it must be handled in acid resisting materials such as lead or some of the chromium-nickel alloys of iron. The digesters are lined with acid-resisting brick. The cooking of the chips requires about eight to twelve hours reaching a temperature of around 150° Centigrade as a maximum, all of the heat being supplied by steam. The waste acid liquor containing the dissolved lignin products is economically valueless and hence is thrown away. The excess of free sulfur dioxide contained in the acid is recovered during the cooking process and aids in strengthening the cooking acid for subsequent cooks.

The soda process is carried out in a similar way using a solution of caustic soda for the cooking. Iron and steel are not attacked by this solution so that the materials of construction in a soda mill are much cheaper than those in a sulfite mill. While there is no gas recovery as in the sulfite process, the spent cooking liquor, called "black liquor" must be recovered for its sodium oxide content. This is accomplished by evaporating the water from the black liquor and incinerating the residue. Enough heat is

available from the combustion to perform most of the necessary evaporation. The residue is leached, yielding a solution of sodium carbonate, which is causticized with lime to produce sodium hydroxide for subsequent cooking. The sulfate process is very similar to the soda process except that the cooking liquor contains a mixture of sodium sulfite with a small proportion of sodium hydroxide. In both of these processes, the lignin compounds are at least utilized to the extent of their heating value.

Chemical pulp is quite brown in color, but with a little dye may be suitable for a variety of uses, such as wrapping paper, paper bags, envelopes and newspapers. Finer uses demand a whiter pulp which is prepared by bleaching the brown pulp with a solution of calcium hypochlorite. The preparation of the bleach liquor is an interesting phase of pulp production. A sodium chloride solution is electrolyzed to yield caustic soda, chlorine and hydrogen. The chlorine is absorbed in milk of lime to produce bleach liquor. The caustic soda may be used for making up the loss of a soda pulp mill or for other chemical uses such as soap making. An excess of chlorine may lead to byproducts like chloroform or carbon tetrachloride or be burned with some of the hydrogen to yield chemically pure hydrochloric acid. Hydrogen recovery has involved one large pulp manufacturing company in the raising of peanuts to supply oil for hydrogenation.

A discussion of the raw materials of paper making is incomplete without a brief description of the utilization of rags. "Rags" includes a variety of materials from clean white cuttings from the shirt factories, through overall cuttings and oily waste to the old rags obtained from house to house collection. The grade of rags used is, of course, dictated by the quality of the paper to be made. The rags are separated from all buttons, pieces of metal, rubber and other foreign material after which they are shredded and cooked with dilute alkali, which loosens the dirt and color. The rags are washed until clean and then bleached to develop the bright white desired.

Let us now direct our attention to the paper-making process where these pulps are blended together and the sheet of paper is formed. The beater is like the cook's mixing bowl, as into it are put the various ingredients of which paper is composed. These ingredients include:

Strong fibers: rag pulp, sulfite pulp, sulfate pulp
Filler fibers: soda pulp, groundwood pulp, repulped paper
Size: sodium resinate
Alum: $Al_2(SO_4)_3$
Mineral filler: clay, talc
Water

A mixture of strong fibers with filler fibers gives a strong sheet of paper with the open spaces between the longer fibers closed by the filler fibers. To prevent feathering of ink, paper is generally sized with a rosin size prepared from rosin and soda. The rosin is precipitated on the fibers by the

addition of paper makers alum, namely aluminum sulfate. Paper which demands a good printing surface also contains a mineral filler which fills in the voids between fibers presenting a smoother surface on the finished sheet. Color is essential to produce a satisfactory paper. There are many shades of white, for example, each one obtained by using the correct proportion of various dyes to get the desired results. Other minor ingredients like starch or sodium silicate may be added for special papers.

The Hollander beater is a large elliptical tank with a vertical partition down the center. A heavy cylinder equipped with bars or knives on its surface and bearing against a rigid metal bed-plate rotates on one side of the partition, beating the pulp as it passes beneath it and causing circulation in the tank. By controlling the pressure of the roll against the bed-plate and the sharpness of the knives, the fibers may be hydrated and fibrillated or may be cut as desired. Other beating machinery may also be employed, but the result is quite similar to the Hollander beater.

The prepared stock is dumped into large chests from which it is pumped to the Fourdrinier machine and mixed with a large quantity of water to a thin suspension. The mold of the ancient paper maker is replaced by a travelling belt of wire screen onto which the pulp suspension flows in a continuous stream and from the other end of which the web of wet paper is continuously removed. The water drains through the wire screen leaving a wet mat of fibers loosely interlaced. The wire passes over suction boxes where more water is pulled away until finally a very wet web of paper is picked off onto a travelling felt to be passed between heavy rollers which press more water from the paper. Thence it passes cver large steam heated rollers where it is dried.

It is then calendered by passing between heavy rolls, which iron the surface of the paper and make it smooth. A highly finished or very smooth paper may experience many passes through the calenders. Special finishes are put on the paper in other ways. A linen finish may be obtained by pressing sheets of paper between sheets of linen cloth. Some paper is not completely dried on the machine, where it will dry under tension due to shrinkage, but is hung up in the air to dry or passed through special drying lofts, where it obtains a fine bubbly surface appearance called "cockle".

Very glossy papers are most readily made by coating the surface of a plain paper with clay or satin white and casein and often with various waxes, which permit a polishing of the surface after drying. Double-coated papers are coated on both sides simultaneously, and during drying must be floated on jets of warm air to prevent touching any surface which might pick off the coating. Some of the floating sections of coated paper dryers are well over a hundred feet in length, during which the paper is supported solely by air jets. The final polishing operation is accomplished by rolls rotating at different peripheral speeds, the friction of slippage producing the polish.

EXPERIMENTS WITH LIQUID AIR

HAROLD A. IDDLES, JAMES A. FUNKHOUSER AND ALFRED H. TAYLOR
University of New Hampshire

INTRODUCTION

The theoretical basis and practical developments for the production of liquid air have been defined clearly in comparatively recent decades. Between 1852 and 1862 J. P. Joule and W. Thomson (Lord Kelvin) in delicate experiments on such gases as carbon dioxide, nitrogen and oxygen measured the change of temperature which occurs when a gas is forced by a high pressure through a small orifice where it is allowed to expand against a lower pressure. This change in temperature is known as the Joule-Thomson effect.

Later it was shown that a gas, passing through an orifice and cooled by the Joule-Thomson effect, could be circulated around the tube leading the compressed gas to the orifice and thus cool the gas issuing from the orifice still more. The "self intensive" or cumulative systems for cooling gases, elaborated by C. Linde, W. Hampsen and C. E. Tripler between 1894-95 are based upon this principle, and finally lead to a low enough temperature to produce drops of the liquified gas which issue from the jet or orifice.

PROPERTIES OF GASES IN THE ATMOSPHERE

	%	*B.P.*	*F.P.*	*At. Wt.*
Helium	0.0004	—268.9	—268.9 (140 atm)	4
Nitrogen	78.0	—195	—214	14
Oxygen	21.0	—182.5	—227	16
Neon	0.0012	—245.9	—248.7	20.2
Argon	0.94	—185.7	—189.2	39.91
Krypton	0.0005	—151.8	—169	82.9
Xenon	0.000006	—109.1	—140	130.2
Radon	—	— 61.8	— 71	222

This work came at approximately the same time as the experiments which led to the discovery of the Inert Gases by Rayleigh and Ramsey. In 1893-95 Rayleigh found that nitrogen produced from ammonium nitrite weighed 1.2506 grams per liter whereas nitrogen from air weighed 1.2572 grams per liter. The difference is much larger than the experimental error involved in the determination and it was therefore inferred that the nitrogen of the air must contain another gas—allotropic nitrogen or some new gas—previously overlooked. The disturbing gas was isolated by Ramsey in May 1894. It proved to be a new gas which was named argon—from the Greek (argos) for inert or idle. By use of liquefaction and fractional distillation, Ramsey found that four other gases could be obtained: helium, neon, krypton and xenon. The neon, helium, argon and contaminating nitrogen pass off first; the xenon and krypton remain and may be separated from one another. By surrounding the mixture of helium and neon with liquid hydrogen (b.p—

252°), the neon freezes to a white solid from which the helium can be removed by the air pump.

GENERAL EXPERIMENTS

Most of the experiments with liquid air fall naturally into two classes: first, those that depend upon the property that even when boiling, liquid air has a very low temperature and second, that upon partial evaporation it furnishes a source of nearly pure oxygen.

Experiment 1. Density of Liquid Air. To show the density of liquid air, a 600 cc beaker may be two-thirds filled with water and 50 cc of liquid air poured upon the water. At first the air will float but soon globules begin to sink as the lighter N_2 (density 0.808) boils away leaving the heavier O_2 (density 1.14). Toward the end of the experiment a test with a glowing splint shows that the gas being evolved is rich in oxygen. Very little ice is formed since the total refrigerating power, the heat of vaporization of the liquid air plus the heat taken up in warming the gaseous air to room temperature, is only about as great as that of the melting of an equal weight of ice.

Experiment 2. Effect of Low Temperature on Some Familiar Things. In demonstrating the effect of low temperature on several objects one may first use a hollow rubber ball which will bounce. After rolling around in a beaker of liquid air until it is thoroughly cool, the ball is hurled to the floor or table and will shatter as though made of glass. A fresh carnation after immersing in liquid air in a transparent glass Dewar will crumble and fall to pieces. An apple, orange or frankfurter after being thoroughly frozen may be cracked into many pieces by using a hammer and an anvil. Cranberries may be frozen by pumping liquid air over them while shaking them until they rattle against the glass like marbles.

Experiment 3. Mercury Hammer. In making a mercury hammer, a mold for the head may be prepared by using a small pasteboard box to which a handle is attached by means of a screw and two washers. The pasteboard form is filled with mercury and lowered into liquid air in a Dewar and allowed to stand until hard. Upon removal the form may be torn off and the hammer used to drive a tack in soft wood. In this condition it is as easily cut as lead. Mercury freezes at —40°C. After use, the hammer may be placed in a beaker of water whereupon a small block of ice will be formed and the mercury will melt.

Experiment 4. Solid Alcohol. In a 100 cc beaker, 30 cc of alcohol and 30 cc of liquid air are stirred together. If the correct amount of air has been used a lump of frozen and half-frozen alcohol will cling to the rod and may be withdrawn from the beaker. The freezing point of ethyl alcohol is —117.3°C.

Experiment 5. Candle of Kerosene. A candle mold is prepared by drawing down the end of a test tube to a conical form and cutting off the tip of the cone. Through the opening a string is threaded to serve as a wick and the tube is half-filled with kerosene and immersed in liquid air. When it

is just frozen, but not too hard, the candle mold is plunged for an instant into water and the candle drawn out, placed in a candle stick and lighted. It burns with the characteristic smoky flame of kerosene.

Experiment 6. Change of Colors. The effect of low temperature on colors may be shown by placing red lead, sulphur, and copper sulphate in test tubes and cooling with liquid air. Red tends to become yellowish; yellows, white; while blues are generally changed but little.

Experiment 7. Air Boiling on Ice. Some liquid air may be poured into a coffee pot and placed on a cake of ice. The air will boil vigorously throwing off a mist and frost collects on the pot. If it is removed, and held in a Bunsen flame, boiling will continue and at the same time a white coating will form, consisting of solid CO_2 (f.p.—78.5°) and frost. Thus the products of combustion have been cooled from the temperature of a hot flame to at least —78.5°C.

Experiment 8. Expansive Force of Liquid Air. Liquid air is placed in a pipe cannon made of brass which is supported in a vertical position and when thoroughly cool a cork is driven into the mouth of the cannon. The cork is forced out with great violence in a few moments and the process may be repeated.

The force exerted by the evaporation of liquid air and subsequent gaseous expansion may be used to run a small toy steam engine. Liquid air is placed in a special safety boiler and this is connected to the engine. The pressure runs the engine for a few minutes although the efficiency is very low.

Experiment 9. Adsorption of Gases. Cocoanut charcoal or other good adsorbent charcoal may be used to produce a very good vacuum since the charcoal will adsorb the gases of the atmosphere at a low temperature. One ordinary manometer tube is filled with mercury to indicate the atmospheric pressure and a second tube with the closed end bent over to make a side arm which contains the charcoal, is placed in a vertical position in a mercury well. Then the charcoal is cooled by holding a Dewar filled with liquid air over the side arm. Soon the mercury level rises until an almost perfect vacuum is indicated. When the Dewar is withdrawn and the charcoal returns to room temperature the adsorbed gas is given off completely.

Experiment 10. Condensation of Gases. If natural gas or Pyrofax gas are available, it may be liquefied by passing it to the bottom of a small distilling flask the bulb of which is immersed in liquid air. Before cooling the bulb the gas issuing from the side arm of the flask may be lighted but when cooled the flame will be suddenly extinguished. After a small amount of condensate has been collected, the gas supply may be turned off and when the flask warms up the condensed gas will boil and may be lighted again at the side arm.

Experiment 11. Elasticity Changes. Wire solder (50-50 Pb-Sn) may be coiled in the form of a helical spring and suspended from a support. At ordinary temperatures it will not hold a weight of a few hundred grams but after cooling in liquid air a weight of 500-1000 grams may be suspended from the spring because of the increased elasticity.

When a lead bell is struck the sound is merely a dull thud whereas a cooled bell will give a sound distinctly metallic in quality.

Experiment 12. Conductivity Change. A small bulb in an automobile headlight reflector is connected through a coil of fine copper wire of about 15 ohms resistance to a battery. The light will glow dimly but when the coil of wire is immersed in liquid air the light will glow brightly due to the increased electrical conductance of the copper wire at the reduced temperature.

Experiment 13. Magnetic Properties. Liquid oxygen is distinctly magnetic. This may be shown by suspending a test tube filled with liquid oxygen so that it is free to swing and placing the tube near a powerful electro magnet with a switch in the electric circuit. By making and breaking the circuit it is possible to build up a decided swing of the test tube. Finally when a tack is dropped into the tube it will be drawn entirely over to the electro magnet.

Experiment 14. Combustion Experiments. Liquid oxygen supports combustion with the production of many exceptional effects. A glowing splint may be plunged beneath the surface and will burn more brilliantly. A piece of kindled charcoal will burn with an intense light. A cigarette and cigar after soaking in liquid oxygen will burn like torches. A watch spring, the ends of which have been covered with sulphur, may be lighted and plunged beneath the surface. It burns and throws off brilliant sparks.

Experiment 15. Aluminum. Powdered aluminum is placed in an iron dish which sits on a cake of ice. Surrounding the ice and dish, explosion screens, made from non-shatterable glass, are placed and liquid oxygen is poured onto the powder. When it has evaporated down to the surface of the aluminum, a long lighted torch is applied to set off the powdered aluminum. It burns with the production of a blinding flash. The temperature changes for this brief period of burning is from —183°C to +3400°C which accounts for the blinding flash and the red hot dish on the cake of ice.

At the conclusion of the liquid air demonstrations Mr. Fiske and Mr. Segerblom of the Phillips Exeter Science Department spoke of the planning and arranging of the Science building pointing out some of the outstanding features of the laboratories and instructional facilities. Some time was then spent in inspecting the building and at four o'clock we were the guests of Mr. and Mrs. Segerblom and Mr. and Mrs. Fiske at tea in the Big Room of Phillips Hall.

W. W. OBEAR, *Secretary*

A sound discretion is not so much indicated by never making a mistake as by never repeating it.

A COURSE IN METHODS OF TEACHING ZOOLOGY

By George Hendrickson
Iowa State College, Ames, Iowa

Several years ago the author was placed in charge of a course new to him and the college, namely, Methods of Teaching Zoology. He had to his credit many hours in Biological Sciences, Education and several years of teaching experience in High School Sciences, but no credit in a similar course and no prepared outline of such a course. As from time to time he has been helped through conversations and typed outlines of other special methods courses in Biological Sciences, it occurs to the author that others might be interested in an outline of the problems taken up in this spring term's course, Methods of Teaching Zoology.

Zoology is broadly interpreted in this course to include all animal study and human physiology and hygiene taught in High Schools, particularly of Iowa. The students are chiefly senior majors in biological sciences who have taken the several courses in Psychology and General Teaching Methods that are prerequisites to the course in addition to the biological subjects. In this three hour-credits course two hours are for recitation and one hour is a laboratory session of three clock hours each week in practice of stocking aquaria, conducting field types, and other actual individual participation by the students.

There follows a list of the problem-topics of the course applied to Zoological sciences.

1. Place of Biological Sciences in Iowa High Schools.
2. Judging and choice of textbooks and manuals in High School Zoology, Biology, and Physiology.
3. Use of textbooks and manuals.
4. Lists of good problems.
5. Pupils' home projects.
6. Aquaria, terraria-live animals in school room.
7. Field trip management.
8. Class collections.
9. Permanent mounts.
10. Visual instruction aids—slides, films, charts, etc.
11. Special exhibits.
12. Clubs, special programs, dramatization.
13. Special devices—clay modelling, blackboard drawings, etc.
14. Examples of successful problem teaching—visits to classes in neighboring high schools of small towns and cities.
15. Books and magazines for schools' and pupils' libraries.

16. Furniture and equipment for schoolrooms.
17. Supplies for laboratory work.

REFERENCES OF SPECIAL VALUE

SCHOOL SCIENCE AND MATHEMATICS—current and bound issues.
Brownell and Wade—*Teaching Science and the Science Teacher.*
Downing—*Teaching Science in our Schools.*
Woodhull—*Teaching Science.*
Westaway—*Science Teaching.*
Catalogs and leaflets of General Biological Supply House, Chicago, Ill.

SCIENCE QUESTIONS

June, 1933

Conducted by Franklin T. Jones, 10109 Wilbur Avenue, Cleveland, Ohio

Readers are invited to co-operate by proposing questions for discussion or problems for solution.

Examination papers, tests, and interesting scientific happenings are very much desired. Please enclose material in an envelope and mail to Franklin T. Jones, 10109 Wilbur Avenue, Cleveland, Ohio.

"PUZZLE" QUESTIONS

622.

Your pupils are frequently puzzled by certain questions which involve simple principles only. Please send in these "puzzle" questions.

THE ICEBERG PROBLEM

623.

Proposed by Walter E. Hauswald, Beardstown High School, Beardstown, Illinois.

A glass tumbler is completely filled with ice water (one more drop of water would cause the glass to overflow) and a large cube of ice is floating in the water. Will the glass overflow when the ice melts, or will the water level fall?

CHECKING UP ON A FINANCIER

624.

Please read the extract from Vanderlip's article given below and tell us

1. How large would a sphere of gold have to be to be worth $100,000 as gold?

2. How large a sphere of gold might be cast from the proceeds of allowing $100,000 to accumulate at interest at 5 per cent, compounded annually for 600 years? To which one of the planets would this be nearest in size?

3. How much would it weigh? Compare with the weight of the Earth.

"One of the great historical financial families was that of the Medici. All through the Renaissance they were the Rothschilds and Morgans of their time. They accumulated a fortune early in their family history, conserved it and multiplied it. . . .

Let us suppose that Averardo de' Medici, just 600 years ago, had accumulated an investment fund equal to $100,000. It would not have been in dollars, of course, so we will visualize it in what would be its equivalent—*a little globe of gold about ——— inches in diameter.* (Question 1)

Now, suppose he had found the secret of "security in investment" and had invested that gold at 5 per cent and left it to accumulate at compound interest until today. Suppose the result could again be turned into a globe of gold.

The size of that globe would be exactly the ——————————, (Question 2) and it would weigh ———— (Question 3) times as much. (It is or is it not obvious that perfect investment security is impossible?) —FRANK A. VANDERLIP in *Saturday Evening Post.* (Jan. 7, 1933, p. 8)

Did you ever hear the "pot of gold" story? It is a problem. Ask the Editor if you want to hear it.

HUNTER OR NOBLE?

617. *Proposed by Joseph A. Nyberg, Hyde Park High School, Chicago, Ill.*

Three gentlemen *A, B,* and *C,* engage in a conversation; from it we are to decide whether each is a Noble or a Hunter. We have two theorems to guide us:

Theorem 1. A Noble always tells the truth.

Theorem 2. Hunter always lies.

A begins the conversation and says either "I am a Noble" or he says "I am a Hunter." We do not know which of these two statements he made.

B says to *A* "You said you were a Hunter."

B says to *C* "You are a Noble."

C says to *A* "You are a Noble."

Solved by Dewey Parsons, Custer High School, Custer, S.D.

The answer is that *A, B,* and *C* are all Hunters.

SOLUTION: Assuming first that *A* said, "I am a Hunter.": if he were a Hunter the statement would be true which is contrary to Theorem 2; if he were a Noble he would be telling a lie which is contrary to Theorem 1. Therefore, this statement was impossible, and *A* must have said, "I am a Noble."

B said to *A,* "You said you were a Hunter." *A* did not make this statement; therefore *B* must be a Hunter.

B then said to *C,* "You are a Noble." This cannot be true because *B* is a Hunter; therefore, *C* must be a Hunter.

C said to *A,* "You are a Noble." This is untrue because *C* is a Hunter; and therefore, *A* also is a Hunter.

(The above was submitted by Hugh L. Demmer, Mathematics Instructor, Custer City Schools, Custer, South Dakota.)

ANALOGY TESTS

625.

Submitted by William Malkin, Cloverton Consolidated School, Cloverton, Minnesota.

"Please permit me to submit two of my analogy tests. The questions in each set are arranged in order of increasing difficulty.

"I will gladly send you other tests in the science subjects, if you can use them. The questions require choice of a term including all the others in a group of terms, or require choice of a term unrelated to the other terms of the group."

ANALOGY TEST ON ANIMALS

Complete the following:

Example: auto : frame :: human body :: ——————

To be read as follows: "Auto is related to frame as the human body is related to ——————." Answer is skeleton.

Therefore: auto : frame :: human body :: *skeleton.*

1. invertebrates	: exoskeleton	:: vertebrates	: ....
2. female gamete	: egg	:: male gamete	: ....
3. Aedes	: yellow fever	:: Anopheles	: ....
4. vertebrates	: "simple" eye	:: crayfish	: ....
5. circulation of blood	: Harvey	:: antiseptic surgery	: ....
6. Columbus	: new world	:: Hooke	: ....
7. Edison	: electric light bulb	:: Leeuwenhoek	: ....
8. country	: governing body	:: cell	: ....
9. stars and heavenly bodies	: astronomy	:: living things	: ....
10. famous family	: Edwards	:: defective family	: ....
11. house	: fumigation	:: milk	: ....
12. land animals	: balanced terrarium	:: water animals	: ....
13. nicotine	: narcotic	:: caffein	: ....
14. building	: bricks	:: tissue	: ....
15. criminals	: imprisoned	:: persons with communicable diseases	: ....
16. fish	: scales	:: birds	: ....
17. best developed neck	: giraffe	:: best developed brain	: ....
18. house	: shingles	:: fish	: ....
19. moving train	: kinetic energy	:: food	: ....
20. living host	: parasite	:: dead host	: ....
21. highest animals	: vertebrates	:: first animals	: ....
22. indefinite shape	: Amœba	:: cigar shaped	: ....
23. organ	: similar tissues	:: tissue	: ....
24. animals	: zoology	:: plants and animals	: ....
25. shutter	: camera	:: iris	: ....

26. camera	: plate	:: eye	: ....
27. higher animals	: alimentary canal	:: Protozoans	: ....
28. mammals	: legs	:: sperms	: ....
29. mammals	: appendages	:: Protozoans	: ....
30. frog	: tadpole	:: butterfly	: ....
31. chlorophyll	: chloroplasts	:: chromatin	: ....
32. fish	: Pisces	:: birds	: ....
33. weight	: pounds	:: food fuel values	: ....
34. living hosts	: parasites	:: scavengers	: ....
35. tunnel	: opening	:: trachea of insects	: ....
36. rays	: starfish	:: pseudopodia	: ....
37. adrenalin	: adrenals	:: insulin	: ....
38. butterfly	: proboscis	:: elephant	: ....
39. vitamin C in foods	: scurvy	:: iodine in water	: ....
40. mammals	: viviparous	:: birds	: ....
41. city	: sewer pipes	:: Paramecium	: ....
42. ducts	: deliver enzymes	:: ductless glands	: ....
43. gluten	: wheat	:: casein	: ....
44. regeneration very evident	: Arthropoda	:: least evident	: ....
45. pancreas and liver	: digestive juices	:: endocrine glands	: ....
46. plants	: diastase	:: saliva	: ....
47. cell	: tissue	:: ommatidia	: ....
48. plants	: flora	:: animals	: ....
49. tadpoles	: breathe with gills	:: frogs when hibernating	: ....
50. individual changes	: metamorphosis	:: slow changes in species	: ....

PROBLEM DEPARTMENT

CONDUCTED BY G. H. JAMISON
State Teachers College, Kirksville, Mo.

This department aims to provide problems of varying degrees of difficulty which will interest anyone engaged in the study of mathematics.

All readers are invited to propose problems and to solve problems here proposed. Drawings to illustrate the problems should be well done in India ink Problems and solutions will be credited to their authors. Each solution, or proposed problem, sent to the Editor, should have the author's name introducing the problem or solution *as on the following pages.*

The Editor of the department desires to serve its readers by making it interesting and helpful to them. Address suggestions and problems to G. H. Jamison, State Teachers College, Kirksville, Missouri.

SOLUTIONS OF PROBLEMS

Note. Persons sending in solutions and submitting problems for solution should observe the following instructions:

1. Drawings in india ink should be on a separate page from the solution.

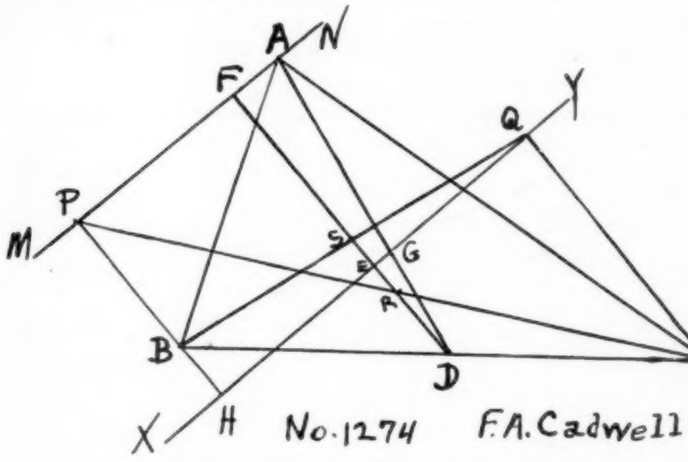
2. Give the solution to the problem proposed if you have one and also the source and any known references to it.

3. In general when several solutions are correct, the one submitted in the best form will be used.

LATE SOLUTIONS

1262–3, 1270–1. *Charles W. Trigg, Los Angeles, Calif.*
1259. *Clarence E. Comstock, Peoria, Ill.*
1274. *Proposed by Murble Pearson, Norman, Okla.*

Given a triangle ABC with the centroid G. Through G any line XY is drawn and through the vertex A, a line MN is drawn parallel to XY. From vertex B a perpendicular BP is dropped to MN, and from vertex C, a perpendicular CQ, is drawn to XY. Prove that the line RS joining the midpoints of PC and BQ is bisected by XY.



Solution by F. A. Cadwell, St. Paul, Minn.

Let PB intersect XY at H and let D be the mid-point of BC.

Draw DA, which will pass through G.

Draw DF perpendicular to XY and MN, intersecting XY at E and MN at F.

Because BP is perpendicular to MN it is also perpendicular to XY and therefore parallel to CQ and DF.

Because D is the mid-point of BC and DF is parallel to BP and CQ, therefore DF passes through R, the mid-point of PC, and through S, the mid-point of BQ.

Since DF is parallel to PB and passes through S, the mid-point of BQ, E is the mid-point of QH and $SE = \frac{1}{2}HB$.

Therefore $2SE = HB$ (1)

Because D is the mid-point of BC and R is the mid-point of PC,

Therefore $$2DR = BP. \qquad (2)$$

Adding (1) and (2), we have:

$$2SE + 2DR = HB + BP. \qquad (3)$$

Because XY is parallel to MN: $\dfrac{DG}{GA} = \dfrac{DR}{ES} + \dfrac{RE}{SF} = \dfrac{1}{2}$.

Therefore $$2DR + 2RE = ES + SF. \qquad (4)$$

$PFEH$ is a parallelogram and therefore $ES + SF = HB + BP$.

Therefore $2DR+2RE=HB+BP.$ (5)

Therefore from (3) and (5), we have:

$$2SE+2DR=2DR+2RE.$$

Therefore $2SE=2RE.$

Therefore $SE=RE.$

Therefore E is the mid-point of RS and XY bisects RS. Q.E.D.

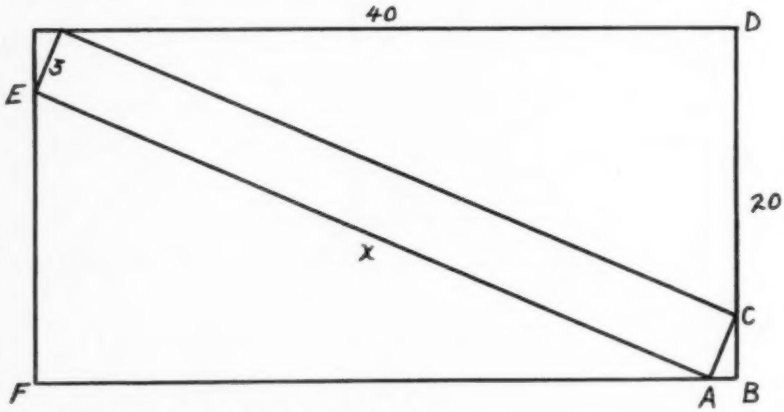
Also solved by Mack Tucker, Bremen, Indiana; John E. Bellards, St. Nazianz, Wis.; D. Moody Bailey, Athens, W. Va.; and the proposer.

1275. *Proposed by Paul Veigle, Loretto, Pa.*

A room is 40 ft. long and 20 ft. wide. What is the length of the longest rectangular strip of carpet that can be laid along the diagonal of room? The width of carpet is 3 feet.

Solved by Edmund H. Umberger, Lebanon Valley College, Annville, Pa.

It is desired to find the longest rectangle of width 3, that can be inscribed in another rectangle of length 40 and width 20.



Angle FAE = Angle BCA = Angle A

(1) $X \cos A+3 \sin A=40$

(2) $X \sin A+3 \cos A=20.$

Eliminating X,

$$3 \sin^2 A-3 \cos^2 A=40 \sin A-20 \cos A.$$

Substituting $\cos^2 A=1-\sin^2 A$, collecting and expanding,

$$36 \sin^4 A-480 \sin^3 A+1964 \sin^2 A+240 \sin A-391=0.$$

Solving, $\sin A=0.407$.

Solving (2) for X and substituting $\cos^2 A=1-\sin^2 A$,

$$X=\frac{20-3\sqrt{1-\sin^2 A}}{\sin A}.$$

Substituting for $\sin A$, $X=42.5$.

Note: Others solving this problem found the values of $\sin A$ and $\cos A$ from (1) and (2) and found the equation which X must satisfy to be

$$X^4-2018X^2+9600X-17919=0.$$

The solution by Horner's method gives 42.447 as a root.

Also solved by Norman Anning, University of Michigan; Wm. H. Johnson, Cleveland, Ohio; W. E. Buker, Leetsdale, Pa.; Mack Tucker, Bremen, Ind.; Delbert Eggenberger, Normal, Ill.; and John E. Bellards, St. Nazianz, Wis.

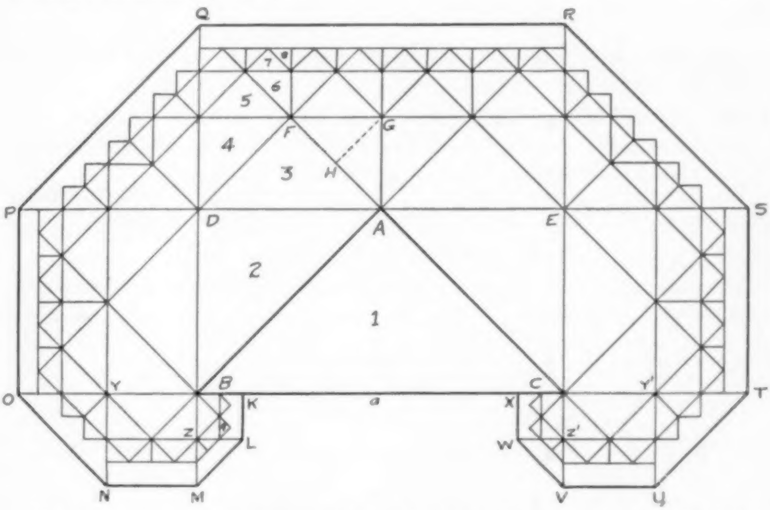
1276. *Proposed by William Wernick, Bronx, N. Y.*

We have an isosceles right triangle with hypotenuse equal to a. With each of the equal legs as a hypotenuse, two new isosceles right triangles are constructed, with the vertex of the right angle outside the original triangle. With each of the equal legs of the two new triangles as hypotenuses, four isosceles right triangles are constructed, with their vertices outside the original figure. This process is continued indefinitely. Is there a limiting area, if so, what is it?

Solved by Charles W. Trigg, Cumnock College, Los Angeles, Calif.

Denote the original triangle and the constructed triangles as triangles of order 1, 2, 3, 4, 5, etc., in order of their decreasing size.

It is evident that the process of construction cannot be continued indefinitely without duplication of area. This duplication begins with the 5th order triangles, e.g., $\triangle GHA$ constructed on GA as hypotenuse duplicates $\frac{1}{2}$ of the area of $\triangle FGA$.



If this duplication be ignored, there is no limiting area, since the total area of each order of triangles is equal to the area of the original triangle, and hence the series formed is divergent.

If only the unduplicated area be considered, there is a limiting area. Since each of the acute angles of the isosceles right triangles is 45°, this angle and the adjacent angle of the constructed triangle form a right angle. In consequence of this property, sides of certain of the successive orders of triangles will coincide with BQ and CR which are $\perp CB$. In further consequence of this property the space between these two lines will be completely filled by the constructed triangles.

The altitude of $\triangle ABC = \frac{1}{2}a$, which is also the altitude of the rectangle $BDEC$ formed by the first and second order triangles. The altitude of the rectangle of the 3rd and 4th order triangles $= \frac{1}{2}DA = \frac{1}{4}a$. The altitudes of the successive rectangles form a geometric series, $\frac{1}{2}a$, $\frac{1}{4}a$, $\frac{1}{8}a$, etc. of which the $S_\infty = a$. Hence the areas of all the rectangles having a as a base approach a^2 as a limit as the construction of the triangles proceeds indefinitely.

In a similar manner, it easily may be proven that the sum of the areas of all the triangles approaches the area of the figure $KLMNOPQRSTUVWXK$ as a limit. In this figure,

$$BO = BD = DP = DQ = ER = ES = EC = CT = \tfrac{1}{2}a,$$
$$BY = YO = YN = BM = CY' = Y'T = Y'U = CV = \tfrac{1}{4}a,$$
$$BZ = ZM = ZL = BK = CX = CZ' = Z'V = Z'W = \tfrac{1}{8}a.$$

$\triangle PDQ = \triangle RES = \frac{1}{8}a^2,$
Square PB = square $ET = \frac{1}{4}a^2,$

$\triangle YON = \triangle UTY' = \dfrac{1}{32}a^2,$

Square YM = square $CU = \dfrac{1}{16}a^2,$

$\triangle ZLM = \triangle VWZ = \dfrac{1}{128}a^2,$

Square BL = square $CW = \dfrac{1}{64}a^2.$

$\therefore$ (adding) area $KMOQRTVXK = 1\dfrac{63}{64}a^2$, which is the required limiting area.

Also solved by Edmund H. Umberger, Annville, Pa. Several incomplete solutions were received.

1277. *Proposed by Cecil B. Read, Wichita, Kan.*

(a) A sum of X dollars, invested at X per cent, compounded annually, doubles itself in X years. Find X, other than 0.

(b) Generalize the case where X dollars invested at X per cent compounded annually becomes in X years X times the original amount.

Solved by W. E. Buker, Leetsdale, Pa.

The compound interest formula is $A = P(1+R)^n$ where the interest is compounded annually.

(a) 1. $X\left(1+\dfrac{X}{100}\right)^X = 2X$ from which

2. $\left(1+\dfrac{X}{100}\right)^X = 2$. Finding the common logarithm.

3. $X \log\left(1+\dfrac{X}{100}\right) = \log 2 = .30103.$

Let $X \log\left(1+\dfrac{X}{100}\right) = Z$. If

$X = 8$, $Z = .26736$, $X = 9$, $Z = .33687$.
$X = 8.4$, $Z = .29425$, $X = 8.5$, $Z = .30116$.
Interpolating, we see that $X = 8.49-$, or 8.5 yrs.

(b) In this case,

1. $X\left(1+\dfrac{X}{100}\right)^X = X^2$, from which $\left(1+\dfrac{X}{100}\right)^X = X$, and

2. $\log X = X \log\left(1+\dfrac{X}{100}\right).$

Let $\log X = Z$, and $X \log\left(1+\dfrac{X}{100}\right) = Y$. Then, if

$X = 1$, $Z = 0$, $Y = .00432$
$X = 2$, $Z = .30103$, $Y = .01720$. Thus, a root lies between $X = 1$ and $X = 2$.

$X=1.1$, $Z=.04139$, $Y=.00480$. The root is nearer 1 than 1.1.
$X=1.01$, $Z=.00432$, $Y=.00436$. Hence it is apparent that X is slightly less than 1.01 years.

Also solved completely by Leo A. Aroian, Fort Collins, Colo., and in part by D. Moody Bailey, Athens, W. Va., and the proposer.

1278. *Proposed by L. W. Hulse, Denver, Colo.*

Show that $X^{4p}+X^{2p}+1$ is not a prime number for X any integer except one, and for p, any integer.

Solved by Hansen Smith, Battle Creek, Iowa

$X^{4p}+X^{2p}+1=(X^{2p}+X^p+1)(X^{2p}-X^p+1)$. Hence, unless one of the factors $X^{2p}\pm X^p+1$ is 1, the proposition is proved.

If $X^{2p}-X^p+1=1$, we have $X^{2p}-X^p=0$, or $X^p(X^p-1)=0$ from which $X=0, 1$. Since both these values of X are excluded by the conditions of the problem, $X^{2p}-X^p+1\neq 1$.

Similarly if $X^{2p}+X^p+1=1$, then $X=0, -1$, and $X^{2p}+X^p+1\neq 1$. Thus the proposition is proved.

Also solved by D. Moody Bailey, Athens, W. Va.; John E. Bellards, St. Nazianz, Wis.; Edmund H. Umberger, Annville, Pa.; O. L. Darner, Scott City, Kan.; Charles W. Trigg, Los Angeles, Calif.; Nathan Nicholson, Philadelphia, Pa.; and W. E. Buker, Leetsdale, Pa.

1279. *From a university list of examination questions for H. S. pupils.*

If the digit 7 is written at the right of a certain number that number is increased by 70,000. Find the number.

Solved by John Kupits, Mathematics Club, South Philadelphia High School Philadelphia, Pa.

Let x equal the number which is to be found.
Then $10x+7=x+70{,}000$
$9x=69{,}993$
$x=7{,}777$, the required number.

Also solved by Cecil B. Read, Wichita, Kan.; R. T. McGregor, Elk Grove, Calif.; W. E. Buker, Leetsdale, Pa.; D. Moody Bailey, Athens, W.Va.; and John E. Bellards, St. Nazianz, Wis.

PROBLEMS FOR SOLUTION

1292. *Proposed by Samuel A. Sloan, Pittsburgh, Pa.*

In the division indicated each dot represents a digit. Find the dividend and divisor.

```
              ..7..
        ....7.|..7.......
               ......
               ------
               .....7.
               .......
               -------
                 .7....
                 .7....
                 ------
                 .......
                 ....7..
                 -------
                   ......
                   ......
                   ------
```

1293. *Proposed by Norman Anning, University of Michigan.*

Progressions of complex numbers are mapped on Argand's diagram. When the progression is arithmetic, the points lie in a straight line. When the progression is geometric, the points lie in an equiangular spiral. What happens when the progression is harmonic?

1294. *Proposed by Chester Siddall, Philadelphia.*

If S_r^n denotes the sum of all the products r at a time of the first n integers it is found that $S_2^n = \frac{n(n^2-1)(3n+2)}{24}$ and $S_3^n = \frac{n^2(n+1)^2(n-1)(n-2)}{48}$. Find a formula for S_4^n and S_5^n. Also give a general solution if there is any for S_r^n.

1295. *Proposed by Edmund H. Umberger, Lebanon Valley College, Anuville, Pa.*

Given the rectangle $ABCD$, with AB equal to 8, BC equal to 6, and O the midpoint of AB. A semicircle, with O as center and AB as diameter, is drawn *outside* the rectangle. A point P is chosen at random inside, or on the semicircle and is joined at O. A line perpendicular to OP at O cuts CD, or CD produced, at R. What is the chance that a line drawn perpendicular to CD at R and cutting the semicircle at S will have a point in common with the segment OP?

1296. *Proposed by L. W. Sires, Wayland, Mo.*

Prove $\cot 7\frac{1}{2}° = (\sqrt{3}+\sqrt{2})\cot 22\frac{1}{2}°$.

1297. *Proposed by R. T. McGregor, Elk Grove, Calif.*

Given the sum of the sides about the right angle and the altitude on the hypotenuse, to construct the triangle.

HIGH SCHOOL HONOR ROLL

The Editor will be very happy to make special mention of high school classes, clubs, or individual students who offer solutions to problems submitted in this department. Teachers are urged to report to the Editor such solutions.

For this issue the Honor Roll appears below.

1278. John Kupits, Mathematics Club, S. Philadelphia.

1279. Hansen Smith, Battle Creek (Iowa) High School; Hamilton Gaillard, Francis Gruther, Harold Kimback and Paul Seifreid, all from Congers (N.Y.) High School; Robert Foster, Monticello (Ill.) Community High School; Russell Magill, Scott Community High School, Scott City, Kansas; Barbara Kimbrough, Lewis and Clark High School, Spokane, Washington; Bell Rogers, Frankfort (Mich.) High School.

BOOKS RECEIVED

Introductory Mathematics, by John Wayne Lasley, Jr., Professor of Mathematics, The University of North Carolina and Edward Tankard Browne, Professor of Mathematics, The University of North Carolina. First Edition. Cloth. Pages xvi + 439. 14.5 x 22.5 cm. 1933. McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York, N.Y. Price \$2.75.

Intelligence, by Paul L. Boynton, Professor of Educational Psychology, George Peabody College for Teachers. Cloth. Pages xi + 466. 13 x 9.5 cm.

1933. D. Appleton and Company, 35 West 32nd Street, New York, N.Y. Price $2.50.

Everyday Problems in Science, by Charles John Pieper, New York University and Wilbur Lee Beauchamp, University of Chicago. Revised Edition. Cloth. Pages xviii + 734. 13 x 19 cm. 1933. Scott, Foresman and Company, 623 South Wabash Avenue, Chicago, Illinois. Price $1.60.

Directed Geography Study, Book One and Two, by Robert M. Brown, Rhode Island College of Education and Mary Tucker Thorp, Henry Barnard School, Rhode Island College of Education. Paper. 19.5 x 26.5 cm. Book One has 192 pages. Price 56 cents. Book Two has 184 pages. Price 56 cents. 1933. World Book Company, Yonkers-on-Hudson, New York.

Other Worlds, by Edwin Lincoln Moseley, Head of the Department of Biology, Ohio State Normal College. Cloth. Pages xi + 230. 12 x 18.5 cm. 1933. D. Appleton and Company, 35 West 32nd Street, New York, N.Y. Price $2.00.

Invertebrate Zoology, by Robert W. Hegner, Professor of Protozoology in the School of Hygiene and Public Health of the Johns Hopkins University. Cloth. Pages xiii + 570. 14 x 21.5 cm. 1933. The Macmillan Company, 60 Fifth Avenue, N.Y. Price $3.75.

An Introduction to Biology, by Elbert C. Cole, Professor of Biology, Williams College, Formerly Instructor in Biology, Hartford Public High School, Hartford, Connecticut. Cloth. Pages xiii + 518. 13.5 x 20 cm. 1933. John Wiley and Sons, Inc., New York, N.Y. Price $1.75.

Modern Higher Algebra, by Webster Wells, Author of a Series of Texts on Mathematics and Walter W. Hart, Associate Professor of Mathematics, School of Education and Teacher of Mathematics, Wisconsin High School, University of Wisconsin. Pages v + 410. 12.5 x 19 cm. 1933. D. C. Heath and Company, 285 Columbus Avenue, Boston, Massachusetts. Price $1.56.

A Textbook of Physics, by E. Grimsehl. Edited by R. Tomaschek, Professor of Physics, The University of Marburg. Authorized Translation from the Seventh German Edition by Professor L. A. Woodward. Volume I—Mechanics. Cloth. Pages xii + 433. 14.5 x 22 cm. 1932. Messrs. Blackie and Son, Limited, 50 Old Bailey, London, E.C. 4. Price 15s. net.

A Textbook of Physics, by E. Grimsehl. Edited by R. Tomaschek, Professor of Physics, The University of Marburg. Authorized Translation from the Seventh German Edition by Professor L. A. Woodward. Volume II—Heat and Sound. Cloth. Pages xi + 312. 14.5 x 22 cm. 1933. Messrs. Blackie and Son, Limited, 50 Old Bailey, London, E.C. 4. Price 12s. 6d. net.

College Algebra, by Joseph B. Rosenbach and Edwin A. Whitman, Associate Professors of Mathematics, Carnegie Institute of Technology. Cloth. Pages xi + 394. 13 x 19.5 cm. 1933. Ginn and Company, 15 Ashburton Place, Boston, Massachusetts. Price $2.00.

Principles of General Chemistry, by Stuart R. Brinkley, Associate Professor of Chemistry, Yale University. Revised Edition. Cloth. Pages x + 585. 14 x 21.5 cm. 1933. The Macmillan Company. Price $3.50.

PAMPHLETS RECEIVED

Instruction in Mathematics, by Edwin S. Lide. Bulletin 1933, No. 17. Pages vi + 72. 15 x 23 cm. Superintendent of Documents, Washington, D.C. Price 10 cents.

New York Survey Tests in Arithmetic, Manual of Directions. Fundamental Operations—Integers. Advanced Examination Grades 4B-8B prepared by The Bureau of Reference, Research and Statistics. 16 pages. 15 x 23 cm. 1932. Publication No. 25. Board of Education of the City of New York, Bureau of Reference, Research and Statistics.

Collegiate Educational Research, University of Minnesota. The Report of the Committee on Educational Research for the Biennium 1930-1932. 32 pages. 21 x 27 cm. Vol. XXVI, No. I, January 17, 1933. University of Minnesota, Minneapolis, Minnesota.

Technical Exposition for the General Reader, by John Mills, Director of Publication, Bell Telephone Laboratories. 11 pages. 15 x 23 cm. February 1933. Bell Telephone Laboratories, Inc., 463 West Street, New York.

Pocket Tables for Cubics, by David Katz, Patent Attorney, South Milwaukee, Wisconsin. Folder of six pages. 9.5 x 22 cm. 1933. David Katz, 1414 Menomonee Avenue, South Milwaukee, Wisconsin. Price 35 cents.

The Science Calendar, Volume I, Number I has 6 pages. 21 x 28 cm. March 15, 1933. Volume I, Number 2 has 9 pages. 21 x 28 cm. April 15, 1933. Published by the Science Department of Woodmere Academy, Woodmere, N.Y.

BOOK REVIEWS

Hygiene, A Textbook for College Students, by Florence L. Meredith, Professor of Hygiene, Tufts College. Second Edition. 832 pp., 230 illustrations. P. Blakiston's Son and Company, Inc., 1012 Walnut St., Philadelphia.

While this text has been written for college students, it does not require a technical training. As the author suggests, it is suited to those whose experience, methods of thought and vocabulary are at the adult level. No laboratory work is required or suggested. It is written for the benefit of readers in their ordinary occupations.

The subject is developed in a logical manner, the work being remarkable for its completeness. A bibliography is given for the benefit of those who desire to go to the sources, but the usual reader will find a sufficient amount of material embodied in the context.

The 64 pages of Part I are devoted to general considerations with the evident purpose to develop in the student a realization of the need for instruction in hygiene and the desirability of voluntary compliance with health regulations.

Part II consists of 154 pages devoted to anatomy and physiology necessary for an understanding of the principles of intelligent body care.

Part III deals with disease conditions, with especial emphasis on measures of prevention.

The 389 pages of Part IV are used in discussion of the different phases of care of the body. The various topics are treated in a clear, matter-of-fact, and illuminating manner. The earnestness and thoroughness of the

author demand utmost respect for the subject, a necessary prerequisite for the development of health consciousness and a desire to develop sane health habits.

Part V is devoted to mental hygiene. The self impulse, the mating impulse, and the social impulse are treated from various points of view. This feature of the book is to be commended. Certainly no treatise in hygiene at this level is complete which does not recognize the psychological problems which must be met and solved in the life of every individual if he is to function to the best advantage in home or community.

The book is recommended most highly not only for class use in colleges but also for any intelligent adult reader and for use as a reference for teachers or others intrusted with the guidance of young people.

J. C. I.

Health Studies, by F. M. Gregg, Department of Education, Nebraska Wesleyan University, and Hugh Grant Rowell, Assistant Professor of Health Education, Teacher's College, Columbia University. Two Volumes, illustrated. *Home and Community,* vi + 258 pp., 75 cents. *Personal Health,* vi + 314 pp., 84 cents. Teacher's Manual for each. World Book Company, Yonkers-on-Hudson, New York.

These two books on health are suited for use in the seventh and eighth grades. There is a distinct need for material of this type which the books seem to meet in an admirable fashion. The plan of the book is unique in that a minimum is devoted to necessary explanation and a maximum of material is intended to develop understandings by means of thought questions and exercises.

The material of the books is organized according to units of instruction—a distinctly modern and sensible mode of attack. Each unit is made up of an introduction, followed by suitable exercises together with problems for investigation. The books are not laboratory manuals, but guides to direct children in the study of their own health problems and to lead them to see their civic responsibilities as members of the community.

J. C. I.

Manual of Biology, by George Alfred Baitsell, Professor of Biology in Yale University. 385 pp. 12 illustrations. The Macmillan Company, New York, 1932.

The manual consists of two parts consisting respectively of descriptive material and laboratory directions. In both cases the material consists of type studies arranged in evolutionary sequence. While the book is titled a manual of biology it is really a manual of animal biology since only two exercises are devoted to a study of plants.

The descriptive material of Part I deals with the same forms as are used in the laboratory exercises. It gives such information as is needed to supplement that to be gained by the student in laboratory study. This serves to make the course remarkably definite and clear. There is no question as to the point to the exercise in any case. Teachers of college classes desiring to offer a course based on type studies in evolutionary sequence should find this manual an excellent guide.

J. C. I.

Recent Advances in Cytology, by C. D. Darlington, Cytologist, John Innes Horticultural Institution, with a foreword by J. B. S. Haldane, Head of the Genetical Department of John Innes Horticultural Institution. 677 pp., 8 plates, 109 text figures and 66 tables. P. Blakiston's Son and Co., Inc. 1012 Walnut St., Philadelphia, 1932.

To write an adequate review of this technical treatise one would necessarily need to be a highly trained specialist in karyology and accustomed to long chains of deductive reasoning. The average cytologist will find it difficult, but at the same time extremely helpful.

The first eight chapters offer a guide to the general student. In these the basis of the subjects of mitosis and meiosis is given in a general way. The context contains material brought up to date which we might expect to find on these subjects. The research worker will find embodied in the work a résumé of hypotheses which serve to suggest some new directions of inquiry. The general biologist will be interested in the fact that the chromosomes are shown in their relation to the organism as a whole not merely as bearers of hereditary characters.

The author indulges freely in statement of hypothesis, some of a speculative kind. He justifies this by quoting from Huxley as follows: "Those who refuse to go beyond the fact rarely get as far as the fact."

The book is a thoroughly scholarly product and should be in the hands of all workers and students in biology not only as a guide but as a stimulus to thought.

J. C. I.

Problems In Biology, by George W. Hunter, Lecturer in Methods of Education in Science, Claremont College and the University of Southern California. 718 pp. Fully illustrated, American Book Company. $1.76, 1931.

The book is divided into four parts as follows: Living Things in Relation to Each Other and Their Surroundings: Green Plants Make the Food of the World; Relationships and Interrelationships of Living Things; The Biology of Man; and Man's Interrelationships with other Living Things. The organization includes under these parts a total of 20 units.

Each unit is carefully organized and logically developed in the five steps: survey, study, test, restudy, and retest.

Each unit is introduced by survey questions accompanied by an interesting half tone picture which calls attention to the main idea of the unit.

A large number of exercises are given in the form of laboratory demonstrations, laboratory exercises, practical exercises, individual projects and field trips. Self testing exercises follow each problem.

A test on fundamental concepts and an achievement test, a review summary and a number of optional practical problems are given at the end of each unit.

The book is profusely illustrated by graphic drawings and half tone pictures.

The large amount of material is offered with the evident idea that selection may be made to suit local conditions. There is some danger in this in that the large mass of material offered may lead to confusion. Another source of confusion might arise from the large number of units offered and from the division of the context into the five parts which on their face seem to represent a duplication of major ideas. As it stands, the material offered represents more work than could be adequately done in a year by any class, elementary or advanced.

The book is built along modern lines and should prove a valuable text if properly used.

J. C. I.

The Microbe Hunters, Text Edition; by Paul de Kruif; edited by Harry G. Grover, Dickinson High School, Jersey City, N.J. 381 pp., Harcourt, Brace and Company, 1932.

A fine piece of work has been done in the editing of this deservedly pop-

ular book. The original edition is so well known as a book of general interest and one especially interesting to young people that a minute description is unnecessary. It is sufficient to say that it deals in a popular way with the relation of microbes to disease. It sets up the dicoverers and pioneers in the field of microbiology, not only as men of science, but also as heroes. Their discoveries are high lights of civilization. The story of Pasteur and the mad dog, for instance, is related in pleasing language and intensely interesting narrative. In a similar style the work of ten other masters in biological research is in each case put in its true significance.

The work is not written in text-book form, but the editor of this edition has added notes, discussion suggestions, and comprehensive questions to go with each chapter as a suggestive guide to those teachers of English and science who may desire to use the material in high school classes. It would be difficult to find material more suitable as an illustration of the application of the scientific method than that exhibited by the stories of microbe hunting. More attention should be paid than is done at present to the heroic patience and unselfish sacrifice that have been displayed by men of science, and especially by those who have blazed the trail.

J. C. I.

General Biology, by Frank M. Wheat, Chairman, Department of Biology, George Washington High School, New York, and Elizabeth F. Fitzpatrick, Chairman, Department of Health Education, George Washington High School, New York. 374 pp. Fully illustrated. American Book Company. 1932.

This text is recommended by the authors as suitable to be used in classes who have had the work in general science or for those who have had a course in general biology, "since there is little repetition in it of the fundamentals offered by the modern type of biology represented in the ninth grade." In the preparation of the book the authors have departed from considerations of types, structure, and function, stressing man as the center of the story.

The context of the book is divided into 47 chapters. The chapters are grouped in the table of contents into 11 so-called units which are really desirable major understandings. The unit idea is not carried out in the organization and presentation of materials of the context.

The illustrations are interesting and significant. Each chapter ends with a series of exercises presented as problems to do, a list of questions, suggestions, and a list of books to read. Provision has been made for selection of a minimum of exercises to be done by the class in general and extra material to be covered by exceptional pupils.

J. C. I.

Directed Geography Studies, Book 1, *The Western Hemisphere*, iv + 188 pages. Book 2, *The Eastern Hemisphere*, iv + 180 pages, by Robert M. Brown, Rhode Island College of Education and Mary Tucker Thorp, Henry Barnard School, Rhode Island College of Education. 1933. World Book Co., New York and Chicago. Price $.56 each.

Each of these workbooks covers a full year's work and is in line with modern one-cycle courses such as are now offered in the fifth and sixth grades in many school systems. In general plan the books present a series of unit-problems outlined in exercises which are to be completed by the pupil through both individual and group study and investigation. Each unit is divided into four sections, A—Exercises to orient the pupil, B—Group and independent study of factors bearing on the problem, C—Activities re-applying facts and principles developed, D—A summary that ties up

the main facts and threads of the development before a new problem is undertaken.

All the widely used texts for the grades are listed for each unit with page assignments, thus making it possible to use numerous texts and permitting adaptation to the ability and initiative of both pupil and teacher. A unit is developed by means of questions, topical outlines, map exercises, graphs, tables, and discussion topics. Whether the books are used with one text or with several, or in the contract or other highly individualized methods, they should help pupils to a better understanding of geographical relationships. The authors give special emphasis to the idea that by effective use of group work the larger appreciations of the special values of the subject will become apparent to the pupil. While this is undoubtedly the result with some teachers the reviewer feels that in general group work develops mainly the pupil already stronger than his fellows and gives those of lesser ability and lower ethical standards an opportunity to favorably press agent themselves, with the result that superficial thinking and intellectual dishonesty often result. This is the reviewer's reaction to all workbooks that foster the group work idea and not just to this series, which is in many ways admirably planned. Independent thought—not group thought would seem to be the need of the hour. Surely geography is a subject in which this can be accomplished. This series is a distinct advance in workbooks. All teachers of geography will find in it much that is of importance and worthy of a try out.

K. U.

Intermediate Algebra, by Joseph B. Orleans, Head of Mathematics Department, George Washington High School, New York City and Walter W. Hart, Associate Professor of Mathematics, School of Education and Teacher of Mathematics, Wisconsin High School, University of Wisconsin. Pages vii + 294. D. C. Heath and Co., New York. 1933.

This book supplies the subject matter for a second course in algebra which is to follow the usual elementary algebra course. The introductory chapter consists of thirteen diagnostic tests covering the work of the first year of algebra. Remedial instruction and remedial exercises are also included. These follow each of the tests.

Graphic representation and functional relations are stressed. An excellent unit on statistics is included, but the authors might well have omitted the unit on logarithms and the trigonometry of the right triangle. Nearly all of the chapters are followed by mastery tests. Four cumulative reviews are included and one general review. The book is attractive, well illustrated and should find favor with teachers of intermediate algebra.

C. A. Stone

Plane Geometry, by Mabel Sykes, Instructor in Mathematics, Bowen High School, Chicago, Ill., Clarence E. Comstock, Professor of Mathematics, Bradley Polytechnic Institute, and Charles M. Austin, Head of Department of Mathematics, Oak Park and River Forest Township High School, Oak Park, Ill. Pages 460. Rand, McNally and Company, Chicago, Ill. 1932.

This book presents the subject matter of geometry in an interesting manner. The beauty and usefulness of the subject is emphasized throughout and many applications to life situations are presented. While the book can easily be used with slow moving classes there is ample material for brighter pupils. In connection with the proofs of theorems a plan of proof or an analysis is presented for the purpose of teaching pupils how to become careful reasoners and thinkers.

The book is divided into units and hence makes possible the unit method of presentation if preferred. However, the reviewer feels that the units are rather small and that many of them could have been combined to make more effective units of work.

The book is more than well illustrated with many excellent pictures, drawings and designs which should prove exceedingly interesting to youngsters. As a whole the book is attractive, has many excellent points and should get a favorable reception from teachers of geometry.

C. A. STONE

Geschichte der Elementar-Mathematik von Johannes Tropfke. Zweiter Bund. Algemeine Arithmetik. iv + 266 pp. Walter de Gruyter and Co., Berlin. R.M. 12.

The second edition of Tropfke's *Geschichte der Elementar-Mathematik* appeared in seven small volumes (1921-1924) and was then commonly regarded as the best history of elementary mathematics in existence. It is interesting that the rapid progress in the history of our subject has made it necessary to publish a third improved and greatly enlarged edition, the first volume of which appeared in 1930 and now the second volume has appeared about three years later. This long delay is evidence of the enormous amount of labor involved in preparing an up-to-date volume dealing with the history of mathematics.

Four subjects whose treatment has been extensively modified in the present edition are: (1) The introduction of general letter symbols, to which 18 pages are devoted in the present edition while in the previous edition only 10 pages were devoted thereto. In the latter it was stated, page 43, that in Pacioli's *Summa* (1494) the thought of using a symbol for a second unknown was first developed, while in the present edition this notion is traced back to the ancient Egyptians. It is also noted in the present edition, page 54, that the ancient Babylonians used non-homogeneous equations and thus advanced to an arithmetization which was formerly credited to R. Descartes (1596-1650). (2) Irrational numbers, to which about three more pages are devoted in the present edition than in the previous one. In particular, the analogies between the theory of Dedekind and that of Eudoxus are noted on page 84 and it is stated that the differences between these theories are only formal. (3) Complex numbers, which are treated now on about 4 more pages than previously. The work of R. Bombelli along this line receives here much more attention than formerly. The student of this subject will find it profitable to compare this treatment with the statement that R. Bombelli "made no advance upon Cardan's theory" found in D. E. Smith's *History of Mathematics*, volume 2, page 262. (4) Logarithms, which are also treated here on about 4 more pages than previously. On pages 206 and 207 reference is made to the connection between logarithms and group theory and on page 252 it is explicitly stated that H. Briggs did not use the technical term mantissa, which is contrary to assertions made in two recent American histories of mathematics.

G. A. MILLER

A Laboratory Manual for General College Zoology, by John Peter Wessel, Harper Brothers, 1933.

This book consists in 92 pages of text and laboratory directions, 32 pages of charts to be filled in by the students as a means of summarizing or comparing the results of their laboratory studies, and an appendix of 17 pages containing a syllabus of the course, a list of materials needed, and 10 pages of review questions.

Aside from the directions for study and dissection of the usual type specimens, this manual contains the following especial features; (1) A set of questions at the close of each exercise, whereby the student may test his grasp of the principles involved in the exercise. (2) A set of tables to be filled out by the student comparing the fundamental structures and summarizing his knowledge of the various forms studied. (3) Directions for a set of experiments in Genetics (Using the banana fly) suitable for use in an elementary class. (4) Directions for a series of exercises on Tropistic reactions, Animal behavior, Biotic successions, and Associations, designed to illustrate these important principles of Animal Ecology without demanding equipment beyond the reach of the average elementary laboratory, and (5) A final set of review questions designed to emphasize the principles illustrated by the laboratory work, and to associate it more closely with the materials discussed in class room and lecture.

The manual shows, throughout, that it is the work of one actively engaged in laboratory as well as class room teaching, and familiar with the problems which arise in the laboratory.

For the sake of the less experienced teacher, one might wish that the directions would so specify, whenever charts or models must be used in making drawings to supplement the student's dissection. Thus, in the study of the reproductive system of the earthworm, the directions call for a dissection and drawing (presumably to be made from the dissection), showing testes, vasa efferentia, etc., although, in the reviewer's experience, the observation of these structures from a gross dissection is a stunt far beyond the average student or instructor either. Similarly in the experiments on "Tropistic reactions," specific instruction as to the method or methods of recording the behavior of experimental animals would be of value.

On the whole, however, the good points of this manual far outweigh the deficiencies. Although written to accompany Dr. Guyer's "Animal Biology," it will be found readily adapted to other texts. The introduction of directions for feasible experiments in Genetics and Ecology fills a need long felt by elementary teachers. The review questions, properly used, will be found helpful and stimulating. The especial merit of this manual is that it bristles with devices and suggestions for laboratory teaching, all of which have been "laboratory tested."

MINNA E. JEWELL

Plane Geometry, by Ray Dwinell Farnsworth, Head of the Department of Mathematics, Chauncy Hall School, Boston, Mass. Pages v + 258. McGraw-Hill Book Co. New York. 1933.

Writers of textbooks of plane geometry in recent years have inclined toward the psychological arrangement of subject matter even at the expense of some formal logic in an effort to make the subject more alive and interesting to the pupil and to enable him to adjust himself to the course more readily. Here is a textbook which offers quite a contrast to most of these. The subject matter is grouped into five books, and the logical development of the subject seems paramount.

Some of the noticeable characteristics of the book follow. The introduction is devoted largely to definitions, assumptions, axioms, and explanations, such as properties of the geometric line and plane. In preparing the exercises the authors have tried to avoid both extremes as to number, difficulty, and classification. The complete proof is given for each theorem. In each case it is preceded by an analysis which should be particularly valuable to the pupil in helping him to develop a method of attacking original problems. The proof is given in paragraph form with only the section numbers cited for the authorities. The author feels that this arrangement

discourages memorizing. Also he follows what is called the unit page. That is, each page is organized as a unit and usually no theorem or paragraph runs over to the next page.

One would hardly call the book attractive. Except for small drawings to illustrate theorems or exercises the pages are completely filled with printed matter. There are no pictures. The reviewer feels that the average class of high school sophomores would find the book formal and somewhat difficult to use. For a class of junior or senior high school students who have a good knowledge of intuitive geometry and who are prepared for a strong course in demonstrative geometry with emphasis on the logical development of the subject this text should prove adaptable and valuable.

G. E. HAWKINS

Modern Solid Geometry, by John R. Clark, The Lincoln School, Teachers College, Columbia University and Arthur S. Otis, Author of Statistical Method in Educational Measurement and Otis Self-Administering Tests of Mental Ability. Revised edition. Pages xx + 323-493. World Book Co., Chicago, Ill. 1932.

This solid geometry is a companion text to Modern Plane Geometry by the same authors. In the introduction several pages are devoted to perspective drawing in an effort to develop the pupils' ability to make suitable drawings of solid figures. This section is carefully developed and should prove valuable to the teacher and pupils. The pupil is given aid in visualizing a plane perpendicular to a line, a plane perpendicular to a plane, etc. in such a manner as to establish the basis for understanding the postulates and definitions of the subject. For the development of computation skill there is a large number of carefully graded practical applications involving both arithmetical and algebraic computation. Most of the exercises are stated in the form of questions. Before the proof of a theorem is given, the plan of proof to be used is outlined and the pupil is encouraged to try to prove the theorem without the aid of the text. The topics of indirect method and analysis are emphasized with special practice and application. The book has excellent drawings and an attractive binding. It merits the attention of teachers of solid geometry.

G. E. HAWKINS

The Radio Amateur's Handbook, by A. Frederick Collins, revised by George C. Baxter Rowe, with an Introduction by Donald McNicol, Editor of Radio Engineering. Seventh edition revised. Cloth. Pages xviii + 419. 19.5 x 13 cm. 1933. Thomas Y. Crowell Company, New York.

The Radio Amateur's Handbook is a complete and informative work on Radio Telegraphy and Telephony. The book is not intended as a text for a course nor is it a handbook in the sense that it is a general reference or source book. The book is written for the amateur and "ham" without the theoretical background beyond the elements of electricity. For those lacking this basis the author has included a chapter, Electricity Simply Explained. The material in this section is purely qualitative. Such topics as self-induction and mutual induction are simply not explained and detract from the rest of the book, which is written in clear simple language.

The book is divided into thirty-six chapters and develops the subject from the simple receiver and transmitter to the modern A.C. receiver with all the standard short-wave and broadcast circuits which have appeared during this development. The theoretical discussion of the operation of these receivers is given in a separate chapter which is preceded by a chapter on the operation and development of vacuum tubes. Three chapters on the Photoelectric Cell, Sound Pictures, and Radiovision are included. The

author has succeeded better in giving a simple basic understanding of the elementary principles than a practical working knowledge of radio. As a result those interested in knowing about radio will find the book better suited to their needs than those interested in experimenting with radio.

The last one hundred pages are devoted to an elaborate appendix consisting of tables of constants, vacuum tube charts, definitions of units, and a glossary of common terms. For the amateur broadcaster the author has included Regulations of the National Board of Underwriters, and Radio Laws and Regulations of the United States.

C. RADIUS

Everyday Problems in Science, by Charles J. Pieper, New York University, and Wilbur Lee Beauchamp, University of Chicago, Revised edition. Cloth. Pages xxxiv + 734. 13 x 19 cm. 1933. Scott, Foresman and Company. New York. Price $1.60.

Everyday Problems in Science is a companion volume to Everyday Problems in Biology by the same authors. The former precedes the latter in use and together they form a two year course in General Science.

The book is built around the unit-problem plan of organization. Each unit commences with a list of questions by which the student is made to draw upon his previous experience. The story of the unit follows and is not a table of contents but a picture of the unit as a coherent whole. This leads the student to the specific problems of the unit, the understanding of which is greatly facilitated by numerous experiments. By dividing the unit into definite problems the authors have showed the students that facts are only of value when used to solve problems. Each problem is concluded with self-testing exercises and each unit with additional exercises. The unit is well illustrated with many diagrams and photographs. Teachers interested in the unit plan of instruction should give this book much consideration.

A special fifteen page introduction "To the Student" deals with the manner in which the student is to study the text. A glossary of reference topics and a pronunciation list are given at the end of the book. The language throughout the book is simple and well suited for the grade in which it is written.

More material is included than can normally be covered in one year. The units on the use of energy for light and communication contain much material which is above the pupil-level for which the book is intended.

Aside from a meaningless design on the cover the book is attractively bound.

C. RADIUS

Science Problems of Modern Life, Book One, by Elsworth S. Obourn, Head of the Science Department, John Boroughs School, Clayton, Missouri, and Ellwood D. Heiss, Head of the Science Department, State Teachers College, East Stroudsburg, Penn. Paper. 21 x 27.7 cm. 1933. Pages v + 201, Webster Publishing Company, 1808 Washington Avenue, St. Louis, Mo. Price $.42 net.

Here is something new and unique, a General Science text, manual, workbook, and notebook all in one. The book is well organized, is liberally illustrated, contains mastery tests, and lists selected references and supplementary materials. Some of the electros were not suited to the paper and produced poor cuts; this can be remedied. Many science teachers will welcome this book because it unifies the work of General Science and reduces the wealth of available material to a workable basis. Book I covers the

topics usually touched in General Science, including air, weather, water, food, light, heat, and machines. It presents a fairly complete course of the subject. The organization of this text is outstanding for its economy and simplicity. Between its covers lies everything the student will need except a pencil or pen. For the sake of better teaching we need to eliminate, and concentrate our subject matter; to meet the present economic trend we have to reduce costs. This book helps to solve these problems admirably.

W. F. ROECKER

Progressive Problems in Physics, Completely revised by Fred R. Miller, Head of the Department of Science, The English High School, Boston, Mass. Cloth. 13 x 19 cm. 1933. Pages vii + 225. D. C. Heath and Company, 285 Columbus Ave., Boston, Mass. Price $1.32.

This book contains 1371 problems covering the usual divisions of Physics; in addition it includes 46 pages of typical examinations—college entrance and regents; an appendix provides in brief form a well chosen set of necessary tables. Teachers of Physics will find this book an excellent source for problem material. The problems are not mere exercises; they are instructive; some are illustrated with diagrams; many are interesting because they present some practical or commercial situation; all of them are organized so as to develop mastery of fundamentals. No answers are given. High school teachers will find this an exceedingly useful book; progressive and stimulating. Recommended highly.

W. F. ROECKER

CLUTE'S
USEFUL PLANTS OF THE WORLD
12 chapters on Foods, Drugs, Dyes, Textiles, Beverages, Gums, Oils, Perfumes, etc. Invaluable for classes in Botany and Home Economics, 234 pages..............$3.75
Other Clute Books
Common Names of Plants, 164 pp. $3.00
Swamp & Dune, illust., 90 pp. $1.50
Botanical Essays, 107 pp. $1.75
A subscription to American Botanist for $1.25 additional
WILLARD N. CLUTE & CO.
Indianapolis, Ind.

Dictionaries - Standard English
3 LETTER WORDS
or 4-LETTER WORDS, 25¢ both 35¢ Definition Stnd. Eng. Words 25¢. Lists of words winning first prize in recent Gold-Medal, Princess Pat, Pathfinder, Bisquick, Magnesia or Wheaties Contest, @ 50¢ 3 for $1.00. List first-prize winners in 30 contests, 25¢. Copy of Contest Magazine, 25¢. Dept. SS, DeLong Agency Inc., Lafayette, Indiana.

CENTRAL ASSOCIATION OF SCIENCE AND MATHEMATICS TEACHERS
Annual Meeting
December 1 and 2, 1933
Chicago, Illinois

Sample Copies for Professional Summer Classes

Those who give summer courses in the teaching of science or of mathematics will find it convenient and helpful to refer to—School Science and Mathemathematics. It will be profitable to present at least one lecture and assignment on the use of standard professional Journals.

Send in your request card and indicate your needs and we will promptly supply you with samples so long as they last.

Write now to
School Science and Mathematics
3319 N. 14th St.
Milwaukee, Wisconsin